TROPICAL DISEASES BUREAU.

TROPICAL VETERINARY BULLETIN.

VOL. 9.] FEBRUARY 28, 1921. [NO. 1.

DISEASES DUE TO PROTOZOAN PARASITES.

BRUMPT (E.). **Les piroplasmes des bovidés et leurs hôtes vecteurs.** [The Piroplasms of Cattle and their Transmitting Agents.]—*Bull. Soc. Path. Exot.* 1920. June 9. Vol. 13. No. 6. pp. 416–460. With 12 figs.

This comprehensive memoir should be consulted in the original by all those who desire to obtain succinct information upon the facts hitherto ascertained with regard to piroplasms in cattle. It is not possible to do more than review the most recent knowledge and essential points in the course of an extract.

Brumpt has been engaged upon a study of the bovine piroplasms since 1913, and, as he states, their identification is not always easy, largely on account of the polymorphism of certain species and also on account of the difficulty of utilising the usual laboratory methods for this purpose. As they are adapted exclusively to living in the blood of cattle and perhaps certain deer or wild cattle, it is impossible to make use of small laboratory animals for their differentiation as one does with trypanosomes.

In order to study them properly one must have at hand clean cattle, obtained from countries free from piroplasms, or animals born and bred indoors. Again, when one works with calves the subject becomes somewhat complicated, as these animals sometimes present infections that remain latent or not apparent and can only be revealed by injecting their blood into older, susceptible, animals. Nevertheless, in spite of these difficulties, it would be a matter of considerable economic interest to identify in a thorough scientific manner the various species of piroplasms.

There are two methods by means of which one may attempt to differentiate the piroplasms of cattle, viz.: (1) by their morphological and (2) by their biological characteristics.

Morphologically, one can by a study of pure and intense forms of infection admit seven species of piroplasms and two species of anaplasms.

Biologically, one may take into account at least seven characteristics :

(1) All species when tested by inoculation are transmissible to clean animals with the exception of *Theileria parva*, the cause of

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East Coast fever. In all cases, except in *T. parva* infection, the infected and recovered animal harbours the parasites in its blood, which may remain virulent for more than 12 years with *P. bigeminum* and for 6 years, at least, with *Anaplasma argentinum*.

(2) The pathogenicity is a very important characteristic and enables one to differentiate various species according to the degree of fever, redwater, anaemia, jaundice, etc., provoked.

(3) The nature of the transmitting agents enables one likewise to determine some species, but this procedure cannot always be adopted, for certain parasites, such as the anaplasms, appear to be spread by ticks of very different species and genera.

(4) Their mode of development in the ticks is almost unknown and the descriptions given by certain authors have not been confirmed by others. This study is incapable, at the present time, of rendering assistance.

(5) The stage in which the tick is capable of becoming infected on the virus-carrying animal and the stage in which it transmits the disease furnish interesting differentiating characters, which enable one to proceed with the application of appropriate preventive measures. The mode of development of each piroplasm remains constant, no matter what transmitting agent is utilised. The author's work on the development of the dog piroplasm makes this point quite clear. [See this *Bulletin*, Vol. 8. No. 1, p. 3, and No. 2, p. 98]. *P. bigeminum*, which passes through the eggs of Margaropus ticks, maintains this same peculiarity when it develops in *Rhipicephalus appendiculatus*. Information with regard to the mode of development and transmission of each piroplasm, as well as the special biology of each tick is, therefore, a necessity in order to obtain some guidance on what is the species or several species of ticks indigenous to any given country that are capable of bringing about the transmission of the parasite.

(6) The best means of diagnosis is the so-called "cross artificial immunity test." In the hands of LAVERAN and MESNIL this test has been of great service in these authors' systematic study of the trypanosomes. The method has also enabled THEILER, MCFADYEAN and STOCKMAN, LIGNIÈRES, and Brumpt to single out some species of piroplasms.

(7) There is, however, a "cross natural immunity test," which is much superior to the above-mentioned artificial immunity test. This test consists in causing animals recovered from a piroplasmosis to be bitten by ticks harbouring a known pure infection. If the bitten animal reacts in the same manner as the control animals the second species with which it was infected would be different from that with which it was originally infected.

This method, in the author's hands, was found capable of furnishing excellent results in the identification of the fowl spirochaetes, and the results, moreover, were quite in harmony with those obtained with the cross artificial immunity test. Thus, fowls hyperimmunised against *Sp. neveuxi* of Senegal become infected on the 6th day, in the same manner as the controls, when bitten by Argas ticks harbouring *Sp. gallinarum*. Therefore, in the course of nature, fowls hyperimmunised against the Senegal spirochaete and despatched to countries where *Sp. gallinarum* exists would become infected and probably die just as readily as clean birds.

Experiments of this kind are difficult to accomplish with cattle, especially on account of material difficulties. However, by using *Margaropus australis* ticks obtained from Brazil, the author was able to set up quite easily in France mixed infections due to *P. bigeminum* and *P. argentinum*, or pure infections due to *P. argentinum*. It was then found that larvæ obtained from the ticks that had produced these infections were quite incapable of reinfecting the recovered animals in spite of the fact that thousands of adult ticks were subsequently recovered on them. A natural super-infection would not thus seem to have taken place. In any country, if the animals have already become infected with one species of tick and then react to the bites of ticks of the same species obtained from other countries and then show piroplasms in their blood, the piroplasms in question would obviously represent different species.

This phenomenon of cross natural immunity can be readily observed if one makes an epizootiological study of the piroplasmoses. Thus cattle imported from Texas and Australia into South Africa do not contract redwater (THEILER); cattle from Southern Italy are resistant towards the same disease when they are imported into Eritrea (CARPANO). On the other hand, animals immunised in Texas against the piroplasms and anaplasms of the country, and animals vaccinated by LIGNIÈRES in Argentina against *P. argentinum* and *P. bigeminum*, die of tristeza in Brazil. It would appear, therefore, that there are piroplasms of the *bigeminum* type in Brazil which are different from those of Argentina and Texas. This view has already been put forward by two Brazilian authors, MIRANDA and PARREIRAS HORTA (1913), who denoted the Brazilian piroplasm *P. australe*.

Preliminary experiments of this kind were undertaken with the dog piroplasms in cattle diseases in order to elucidate this problem of high scientific and economic importance.

The author then passes under review the different species of cattle piroplasms which he considers valid in our present state of knowledge.

Piroplasma bovis (Babès 1888 pro parte).

Syn. *P. divergens*, MCFADYEAN and STOCKMAN, 1911; non *Microbabesia divergens*, SOHNS, 1918.

The parasites originally insufficiently described by BABÈS in 1888 in the red blood corpuscles of cattle dying of redwater in the marshy Danubian plains belonged, it would seem, to two different types, viz., (1) a small piroplasm which has since been seen in various parts of Europe, and (2) a large piroplasm which can be no other than *P. bigeminum*, SMITH and KILBORNE, of world-wide distribution. These two species in fact have been found in Bulgaria by MARKOFF (1916), and as far back as 1900 LIGNIÈRES received from a certain locality in Roumania, where redwater was in existence, two species of ticks: (1) *Ixodes ricinus*, the transmitting agent of *P. bovis*; (2) *Margaropus calcaratus*, which transmits *P. bigeminum*, as Brumpt himself has demonstrated experimentally with samples of this species collected in Tunisia by NICOLLE (Ch.). It is, therefore, certain that BABÈS saw two different species of piroplasms. Inasmuch as he would appear to have described in the first place the smaller one, Brumpt maintains that by the application of the law of priority the specific name *bovis* should be maintained to denote this small European species, and that the specific name *bigeminum* should be relegated to the large species found in the south of Europe and in tropical countries, the name *bigeminum* being that originally applied to it by SMITH and KILBORNE.

P. bovis has thus been found in the ox in Roumania, France, England, Finland, Germany, Holland, Denmark, Italy, Switzerland, Bulgaria, Russia, Norway, Sweden, Belgium, and Portugal. According to BETTENCOURT, FRANÇA and BORGES it is also found in the stag (*Cervus elaphus*).

Quite recently VRIJBURG [*see* this *Bulletin* 1919. Vol. 7, p. 14] wished to identify the species with *P. argentinum*, LIGNIÈRES and *P. annulatum*, DSCHUNKOWSKY, basing his contention upon the morphological aspect of certain forms of these parasites. This view, according to Brumpt, is quite indefensible, for it would appear to be controverted by clinical observations and experimental tests. By means of the cross immunity test Brumpt showed that an animal recovered from a *P. bovis* infection (Normandy strain) was susceptible to *P. argentinum*. Moreover, by the agency of ticks, he was able to transmit neither *P. argentinum* by means of *Ixodes ricinus* nor *P. bovis* by means of hundreds of samples of *Margaropus australis*.

P. annulatum is discussed later.

A Dutch author SOHNS (J. C. F.) in 1918 described under the name *Microbabesia divergens* in the Dutch East Indies parasites which he identified with the European piroplasm and also with *P. argentinum* [*see* this *Bulletin*, 1919, Vol. 7, No. 1, p. 15].

Judging from the description and figures given by this author, Brumpt considers rightly that none of these forms can be attributed with certainty to *P. bovis*, and none of them is placed at the periphery of the corpuscle as is frequently seen in pure infection due to this parasite. Moreover, the piroplasms described by this author were transmitted by Margaropus and, as Brumpt has shown, this kind of tick cannot propagate *P. bovis* (= *divergens*). It is probable, Brumpt maintains, that SOHNS was dealing with a mixture of *P. bigeminum*, *Theileria mutans*, and probably *P. argentinum*, or, at least, a species which resembled it morphologically.

P. bovis is transmitted by *Ixodes ricinus* (KOSSEL, WEBER, SCHUTZ, and MIESSNER, 1903), and transmission is hereditary: larvæ obtained from ticks collected on affected animals proved infective. Likewise these authors showed that the nymphs obtained from infected larvae were infective. In this respect the piroplasm would appear to be very different from *P. canis*, but it is just possible that in the experiment in question the infection might have been transmitted hereditarily and preserved up to the nymph stage. In England, STOCKMAN and NUTTALL have proved the part played by larvæ in infection.

In France Brumpt had numerous failures in attempting to infect young animals with the larvae, but it was not possible to ascertain whether these animals had contracted a latent infection. He succeeded in transmitting the infection to a calf by allowing it to be bitten by nymphs that had retained the infection hereditarily or that had contracted it on young animals harbouring a latent *P. bovis* infection. From his epizootiological studies it would seem that adult *Ixodes ricinus* prove infective only in a small percentage of cases. It was not found possible to infect a calf by causing it to be bitten by hundreds of adult ticks of this species which, as nymphs, had infected the calf mentioned above. But, here again, a test of the virulence of the blood could not be undertaken. STOCKMAN succeeded in transmitting this parasite, or perhaps the large English piroplasm (for this author does not give precise details on this point), by means of another cattle tick *Hæmaphysalis punctata* CAN and FANZ; on

analysing the results of his experiments Brumpt concludes that this tick is only by accident a transmitting agent and is less adapted for the purpose than is *Ixodes ricinus*. The nymph only appears capable of playing a part in the development of the parasite. In France the disease is transmitted by *I. ricinus*, which is abundant everywhere ; *H. punctata* is rarely found and Brumpt found only one sample of this tick on cattle in the west of France in 1917 and 1918. On the other hand he often found *Dermacentor reticulatus*, from October up to the end of April, but this species cannot act as intermediate host inasmuch as it disappears when the first cases of piroplasmosis are observed and re-appears when cattle piroplasmosis disappears.

In France this piroplasm produces a rather low mortality—4–8 per cent. of those that become affected with redwater succumb. The period of incubation varies from 5 to 28 days. Fever is observed for 1 to 7 days (up to 41° C.), redwater appears as a rule 2 or 3 days after the commencement of the fever and lasts 1 to 4 days. The symptoms are especially marked in aged cattle. In Norway it appears that 100 per cent. of affected cattle may die of the disease, and in Germany sometimes up to 50 to 60 per cent. According to Moussu and other authors treatment by means of trypan blue is efficacious.

Piroplasma argentinum, Lignières, 1901.

This parasite was specially described by Lignières in 1901 in Argentina, and designated by the above name in 1903. It is always very rare in the red corpuscles in the peripheral blood. (In 1898, however, A. Bettencourt encountered in Portugal in 13 cases of redwater a small parasite from 1 to 2 microns in diam., which was always very rare in the peripheral blood and resembled fairly closely *P. argentinum* ; *P. bovis* and *P. bigeminum*, it is remarked, are generally quite abundant in the blood). Even in the acute forms of the disease it is sometimes difficult to find these parasites, but they occur in abundance in the heart muscle and in the kidneys. The corpuscles which contain the parasites are often very small in size ; the rounded forms of the piroplasms are generally seen singly within the corpuscles in the peripheral blood, rarely in twos, threes, or fours. Their average diameter is 1 to 1½ microns. Pear-shaped forms are fairly often seen which are two or three times smaller than those of *P. bigeminum*, and when they occur in pairs they are inclined towards each other at a divergent angle in much the same way as *P. bovis*. A characteristic which enables one to distinguish these parasites from those of the latter species is that they are never placed towards the surface of the red corpuscle.

Brumpt believes from the descriptions given by Ziemann (1902) that this parasite is found associated with *P. bigeminum* in Venezuela. It also occurs in Brazil and probably in the Panama region, where it was found by Clark in cattle and deer. Forms resembling it morphologically were found by Brumpt in a Brazilian deer.

Lignières transmitted the infection with *Margaropus australis*, and Brumpt succeeded also in transmitting it in France with ticks of the same species obtained from Brazil. The disease produced by the parasite appears to be more severe than that produced by *P. bigeminum* alone. According to Lignières, one can vaccinate against *P. bigeminum* by means of *P. argentinum* and vice versa. In mixed infections the disease does not appear to be more severe than in

infections produced by *P. argentinum* alone. The parasite has not been encountered in Europe, and it would appear that the species was originally harboured by the South American deer. Treatment with trypan blue appears to be efficacious in some cases.

P. bigeminum, SMITH and KILBORNE, 1893.

Described in the classical researches of SMITH and KILBORNE in the United States in 1903. This is the best known piroplasm of cattle. The rounded form is common and elongated or ovoid forms are not rare, but the pear-shaped forms are the most characteristic. Even the smallest pear-shaped forms are swollen in appearance, so that they can be easily distinguished from *P. bovis* and *P. argentinum*. In acute cases of the disease 5 to 75 per cent. of the red corpuscles in the peripheral blood are invaded, while in the viscera, and especially in the heart muscle and kidney, from 20 to 80 per cent. contain the parasites.

This piroplasm exists in Europe in districts where Margaropus ticks are found—that is, in low-lying districts below 44° Lat. It has been found in Roumania, Greece, Bulgaria, Italy and in Portugal, and probably also in the South of Spain. This is interesting, inasmuch as it was from that country that animals were first exported into America, and the causal agents of Texas fever would, therefore, have originated from that country. The Margaropus tick of Southern Europe (*M. calcaratus*) does not appear to have been carried over in this way, but in America there are other species of this genus, *M. annulatus* and *M. australis*, which would appear to have acquired the capacity of acting as vectors. Inasmuch as these last-named ticks cannot live in North America above 37° Lat. and in South America below 35° Lat, one can understand why the infested zone in America is less extensive than in Europe, where it reaches 44° Lat., owing to the difference in the biology of *M. calcaratus*. The parasite is also found in many other parts of the world, usually associated with *Theileria mutans*, *Anaplasma marginale*, or other piroplasms. It has been found in Eritrea at an altitude of 2,400 metres. The species found in Texas, India and Madagascar are no doubt identical with that found in South Africa, for animals imported from those countries into South Africa behave like immune animals. Sardinian cattle imported into Eritrea contract only a slight disease, due to *T. mutans*. Zebus from India and Madagascar survive quite well in tropical America, so that they are likewise insusceptible to infection with *P. argentinum*.

On the other hand, cattle imported from Texas into Brazil succumb to piroplasmosis, so that the species found in Brazil is probably different.

There also exists in Northern Europe a piroplasm identical morphologically with *P. bigeminum*. Its presence has been recorded in England, Finland, Holland and Germany, but it has not yet been seen in France. In some cases this parasite appears to have a high degree of pathogenicity.

M. annulatus passes the whole of its development on one host, so that infection takes place only by hereditary transmission. In South Africa the common vector is *M. decoloratus*. In Asia Minor *M. calcaratus* transmits the disease. When larvae obtained from infected females develop on immune animals, such as the sheep, horse, etc., they become non-infective. However, THEILER recorded a case in which larvae obtained from ticks collected on a horse were infective. Very

few species other than those belonging to the genus Margaropus are capable of acting as vectors. In the United States *Dermacentor variabilis* and *Amblyomma americanum* have been proved to play no part in transmission. *Ixodes ricinus* and a nearly related species, *Ix. scapularis*, do not appear to play any part. Clean *M. annulatus* placed on an animal infected six years previously became infected. Nevertheless, THEILER transmitted the infection by means of a dropping off tick, *Rhipicephalus appendiculatus*. It seems possible that the somewhat rare presence of the parasite in Northern Europe is the cause sometimes of rupture of the spleen. According to KNUTH, *Haemaphysalis punctata* would appear to be able to transmit the disease, in the same manner as, according to STOCKMAN, it transmits *P. bovis*. It is well known that the parasites persist for a long time, up to 12 years, in the blood of a recovered animal.

Piroplasms and Rupture of the Spleen.

Cases of sudden death, due to spleen rupture, have been observed in cattle in Germany, Holland and Denmark for some time, and the disease is only seen while the animals are out at grass, in the spring or early summer, and it generally occurs in open flat spaces that are not wooded, where *H. punctata* is found abundantly. *I. ricinus*, on the other hand, is found most commonly in marshy and wooded districts. The condition is seen in adults, very rarely in young animals, and after a short period of incubation. Cases usually occur singly in a herd, and may be easily mistaken for anthrax. KNUTH recorded the affection along the Baltic and North Sea coasts, and alleged that it did not occur in countries where tropical bovine piroplasmosis existed. However, it seems to have been described by NICOLLE (M.) and ADIL BEY (1899) in Constantinople, and by CLAUDE and SOULIÉ in 1901 in Algeria, and there still remains some dispute whether spleen rupture is due to a particular species of piroplasm which is different from *P. bovis* or *P. bigeminum*, while some authors consider that the condition has nothing to do with piroplasmosis. Relapses are well known to occur in cattle during an attack of some depressing affection such as rinderpest and East Coast fever, or in overworked, ill-nourished, low-conditioned animals. It would also appear that no worker has yet succeeded in reproducing this splenic condition, resulting in sudden death, by inoculation experiments, but the tests are not numerous enough to draw therefrom settled conclusions, although there seems to be no doubt that it is associated at least in Northern Europe with piroplasmosis. In Holland, Germany and Denmark observers claim that there is a difference in the geographical distribution of the two conditions—redwater and spleen rupture followed by sudden death—and DE JONG and KNUTH'S views that the latter condition is caused by a particular type of piroplasm are therefore feasible.

Theileria parva (THEILER 1904).

Syn. *Piroplasma annulatum* DSCHUNKOWSKY and LUHS, 1904 *pro parte*; *P. kochi* LIGNIÈRES, 1905. Not to be confounded with *T. mutans*. In *T. parva* infection from 80 to 96 per cent. of the blood corpuscles are infested while in *T. mutans* infection rarely more than 50 per cent. are invaded.

This parasite was first recorded on the East Coast of Africa. It was imported into Rhodesia in 1901, and to the Transvaal in 1902. It is found also in Uganda, Eritrea, Egypt, Cyrenaica, Tunisia, where it

has been described in summer (DUCLOUX 1905), Transcaucasus region, Macedonia, and India (MONTGOMERY). According to KOCH zebus imported from the northern part of Madagascar into East Africa resisted the disease, while those from the south succumbed. The disease has not yet been found in the Belgian Congo and in West Africa, where, however, certain species of ticks that might be capable of transmitting it have been recorded. The same or nearly related species have been found in Uganda by Ross (P.H.) in 1909 in a hartebeest, and by LICHTENFELD in 1911 in German East Africa in an eland antelope. These antelopes were probably the original vertebrate hosts of *T. parva*, but at present the reservoir is the domestic cattle.

The common vector is *Rhipicephalus appendiculatus*(=*R. nitens*) which changes its host three times, becomes infected in the larval or nymph stage, and transmits the infection in the succeeding stage; infection is not hereditary; the tick becomes infected in from 95 to 100 per cent. of cases. The continuous feeder *Margaropus decoloratus* does not transmit the infection. *Rhipicephalus evertsi*, which changes its host twice, and *R. capensis* and *R. simus*, which leave their host for each moult, are capable of transmitting the infection (THEILER). According to NUTTALL and HINDLE, *R. appendiculatus* does not become infective for two or three days after becoming attached to a susceptible animal.

CARPANO considers that *Hyalomma aegyptium* is the vector of *T. parva* and *T. mutans* found in Mediterranean Coast fever. This tick lives normally in the larval and nymphal stage on small animals, such as rabbits, hares, birds and hedgehogs, from which it cannot obtain the piroplasms. In natural conditions it is found on cattle in the adult stage. Brumpt found experimentally that the larvae of some broods were capable of developing on cattle and that the nymphs that had lived as larvae on the rabbit were capable of becoming engorged on these animals—thus lending support to CARPANO'S view. It is probable that in Macedonia, the Transcaucasus region, and Tunisia the vector is perhaps *R. simus*, which exists in Egypt and Mitilene or, more likely, *R. bursa*, which is very common on cattle in all its stages, or yet *R. sanguineus*, which may be accidentally found on cattle. The mortality from this condition among adult animals is from 95 to 100 per cent. Recovered animals acquire a permanent immunity and the parasites disappear completely from their blood and glands.

Theileria mutans (THEILER 1906).

Syn. Th. sp. DODD, 1910; *Piroplasma annulatum*, CARPANO, 1915; *non* DSCHUNKOWSKY, 1904; *T. parva*, CARDAMATIS, VELU, etc.

This parasite, which presents an identical appearance to *T. parva* in the peripheral blood, is easily distinguished from it by the absence of the characteristic schizogonous bodies (KOCH'S blue bodies), by its relatively slight pathogenicity, and the ease with which it can be inoculated into susceptible animals. It is of widespread distribution and is also met with in infections due to *T. parva*, a fact which rendered experimentation with this species difficult for many years. The red corpuscles are not changed, but contrary to what takes place with *T. parva*, there must be a fairly considerable destruction of the corpuscles in certain countries and in certain seasons and under certain influences. For in fatal cases one observes very intense anaemia and

corpuscular changes and jaundice, but never redwater. In British East Africa MONTGOMERY rarely found 10 per cent. of the corpuscles invaded. In Algeria SERGENT (Ed.) and LHÉRITIER observed 30 per cent. invaded in animals in apparent good health. In Morocco VELU and EYRAUD recorded in native cattle a short time before death 27 to 55 per cent. corpuscles invaded, sometimes with five parasites per corpuscle.

The parasite has been found associated with *P. bigeminum* throughout the whole of Africa, S. Europe, S. Asia, and Australia. It has never been found in America, in spite of the importation of large numbers of zebus from India and Africa. It is found at high altitudes (2,400 metres at Asmara and above 2,100 metres in the Himalayas). Similar or identical species have been found in the carabao buffalo and in a number of deer and antelopes.

The piroplasm is transmitted by *R. simus*, *R. evertsi*, and more rarely by *R. appendiculatus*, but not by *Margaropus annulatus* (THEILER). The ticks become infected as nymphs and transmit the disease in the adult stage.

Brumpt failed to transmit this piroplasm in France by causing susceptible animals to be bitten by larvae of *Margaropus calcaratus* and *R. bursa* collected on native animals in Asia Minor, or by adult *Hyalomma aegyptium* transplanted from an African ox to a susceptible animal or obtained from broods of larvae and nymphs from the hedgehog. CARPANO (1915) believed that *Hyalomma aegyptium* was the intermediate host of *T. parva* and *T. mutans* in Cyrenaica. Inasmuch as the piroplasm is not passed on hereditarily through the ticks, one has to study ticks living at various stages of their development on cattle in order to ascertain the European or African transmitters of the piroplasm. *R. bursa*, and to some extent *R. sanguineus*, appear to be the most likely transmitters judging by their life history, and the appearance of the piroplasm in July in Algeria gives support to this view.

The period of incubation according to THEILER after infection with *R. appendiculatus* is from 28 to 58 days, with *R. evertsi* 29 days; by inoculation it is much shorter, 4 to 10 days in adult animals up to the commencement of the fever, and 5 to 15 days up to the appearance of parasites. Brumpt inoculated three calves with blood from adult Tunisian cattle and parasites appeared in their blood in 14, 27 and 40 days respectively, but no clinical symptoms were seen. Fever lasts a few days and generally the animal recovers, although under certain conditions, *e.g.*, rinderpest, excessive heat, etc., immune animals may suffer from relapses and even succumb. In Asia Minor the parasite is constantly associated with *P. bigeminum* and *Anaplasma marginale*, and it appears to become pathogenic in certain conditions for some unknown reasons. In Morocco VELU and EYRAUD observed several fatal cases in adult native cattle during the very hot season, and from 52 to 55 per cent. of the blood corpuscles were found infested. Recovered animals always show the parasite in their blood.

Anaplasma marginale (THEILER 1910).

Syn. (?) *A. argentinum* LIGNIÈRES, 1914; *A. Theileri* CARDAMATIS, 1911.

These are in the form of spherical masses rarely attaining 0.5 microns in diameter and situated generally at the margin or near the margin

of the corpuscles. Their pathogenicity was first demonstrated by THEILER, but the bodies were pointed out by SMITH and KILBORNE in 1893, who, however, considered them to be developmental stages of *P. bigeminum*. Brumpt admits that it is often impossible to distinguish morphologically a true anaplasm from Jolly bodies. A distinction between them is quite easy to make experimentally as the former become reproduced in susceptible animals after inoculation, while the latter are incapable of multiplying. The author agrees with LIGNIÈRES in this respect, and maintains that no investigator can have any doubt at the present time about the parasitic nature of the cattle anaplasms. The ox, zebu, and buffalo are infected naturally, while LIGNIÈRES showed that the sheep and goat are susceptible and presented latent infections of long duration.

The parasites are found almost everywhere associated with *P. bigeminum* and *T. mutans*, but in certain localities (in the Transvaal, Argentine, and Brazil) the anaplasms have been found in a state of purity. It would appear that the parasites are unknown in Australia but the immunity exhibited by Australian animals after importation to South Africa would tend to show that the parasite is to be found in certain parts of Australia. Cattle are known to suffer from anaplasmosis in Italy, Greece, Algeria, Tunisia, the whole of Africa, America, S. Asia, and the Transcaucasus. The parasite is demonstrated by inoculation of blood into susceptible animals, but the infection thus produced is most often a mixed infection with *A. marginale* and *A. centrale*.

The only positive experiments in tick transmission are those of THEILER. In three cases *Margaropus decoloratus* larvae raised on affected animals produced infection in 52 to 78 days. One experiment with the larvae of *R. simus* obtained from females collected on immune animals gave a positive result in 75 days. Infection is therefore hereditary. Brumpt failed to infect animals by placing on them large numbers of *Margaropus calcaratus* and *R. bursa* from Morocco, Algeria and Tunisia collected from immune animals. But larvae obtained from numerous *M. australis* females collected on immune animals in Brazil, and found capable of transmitting *P. bigeminum* and *P. argentinum*, together with *Spirochæta theileri*, did not transmit the anaplasms invariably found in the blood of the Brazilian cattle. In the United States SMITH and KILBORNE (1893) do not appear to have succeeded in transmitting "marginal points" by the agency of Margaropus, but transmission took place by inoculation of blood and the parasites were seen in animals living in the open and infected spontaneously. In South Africa, at a latitude of about 25°, anaplasmosis is seen throughout the year, but it is most common in summer. The disease reveals sometimes a latent infection due to *P. bigeminum*.

Anaplasma centrale (THEILER 1911).

This species is distinguished by its central position inside the corpuscle and by its almost complete absence of pathogenicity. But, as THEILER has shown, inoculation with *A. centrale* immunises against *A. marginale* infection. WALKER, however, showed that blood from certain animals that had harboured a pure *A. centrale* infection when inoculated a few months later into susceptible animals produced a *marginale* infection which was sometimes fatal. It is very likely, however, that the animals had become accidentally infected with *A. marginale*. Transmission takes place by *Margaropus decoloratus* (THEILER) and

the period of incubation was in one case 55 days and in the second 114 days. After experimental inoculation the period of incubation is much shorter, 16—47 days. The blood of recovered animals is virulent.

Anaplasma argentinum (LIGNIÈRES, 1914).

This parasite was probably originally imported from Spain into America with cattle, and it is morphologically identical with *A. marginale*. It was discovered in Argentina by KNUTH, who, however, considered it to be a stage in the life cycle of *P. bigeminum*. LIGNIÈRES demonstrated the specificity of the parasite, which he observed in the blood in 20 to 23 days after inoculation, and like *A. marginale* it produces intense anaemia and no redwater. The parasites may infest 45 per cent. of the corpuscles in severe cases, and pure anaplasmosis produces a higher mortality than the piroplasmoses in Argentina, amounting to 50 per cent. in young animals and 95-100 per cent. in adults. According to LIGNIÈRES, jaundice is not of common occurrence and this characteristic enables one to distinguish the Argentine type of gall-sickness from the African type. The blood of recovered animals remains virulent for at least six years.

The parasite is not transmitted by *Margaropus australis*, and LIGNIÈRES incriminates a tick of the genus Amblyomma. The anaplasm can be inoculated into the sheep and goat but not into the horse, pig, and small laboratory animals. The sheep and goat develop a latent infection after inoculation of virulent blood, but blood from these animals when inoculated for even up to a year afterwards into susceptible animals produces an acute anaplasmosis. The virus can be attenuated and used as a vaccine by repeated sub-inoculations into sheep.

The author then appends some notes on two piroplasms, one observed in Canada and the other in the Gold Coast.

Piroplasma hudsonius bovis (BOWHILL, 1908). While investigating a redwater of cattle in British Columbia BOWHILL discovered in the blood of affected animals a typical piroplasm showing pear-shaped and polygonal forms, and very rarely bigeminate forms. The parasites were as a rule difficult to find. The disease caused by the piroplasm was chronic in its course and relapses occurred. Affected animals succumbed as a rule after the third attack. The tick collected on these animals would appear to be *Dermacentor venustus*, which is widespread in distribution in North America, and is the transmitter also of Rocky Mountain fever, and tick paralysis in man and sheep.

Achromaticus macfiei (C. FRANÇA, 1918). This parasite was observed by MACFIE associated with *P. bigeminum* and *T. mutans* in the blood of a cow that had died at Tamale, in the north of the Gold Coast, and it would appear to be highly virulent. The parasite assumed various forms, rounded, triangular, fusiform, amoeboid, but it differs, according to FRANÇA, from the piroplasms already described on account of the shape of its nucleus, which is always rounded and often centrally placed in the rounded forms. The mode of division also appears to be quite different from that observed in the other piroplasms.

Jaundice in Cattle in Northern Africa.

Cattle in Algeria and Tunisia are often attacked with various diseases which show in general symptoms of more or less pronounced jaundice, profound anaemia, and high fever, and sometimes redwater.

It is probable that these conditions are identical with those studied under the name of gall-sickness and other such names in South Africa. Brumpt considers that the jaundice is referable to different diseases, and in particular:

(1) Piroplasmosis due to *P. bigeminum* and transmitted by *Margaropus calcaratus*; this condition is seen throughout the year in animals imported from France, but it is especially frequent during the spring.

(2) Affections observed most often in summer and caused by *T. mutans* in immune animals. This disease is not accompanied by redwater and trypan blue proves of very little use in its treatment.

(3) Anaplasmosis. The blood of nearly all adult cattle in Northern Africa harbours *A. marginale*, which produces a disease without redwater and identical clinically with the preceding piroplasmosis.

(4) A disease recently specially described by SERGENT (Ed.) and LHÉRITIER, the etiology of which appears to be unknown and which is designated for the sake of convenience under the name haemoglobinuric biliary fever of the ox. This condition is seen in May, June, July and August, and in districts where it is enzootic the mortality is not high, rarely 2 to 5 per cent. of the total herd. On the other hand in animals recently imported from France or brought down from the higher plateaux the mortality rate may be quite considerable. It varies also in virulence in different years, and on certain farms it was noticed to occur simultaneously with *P. caballi* infection in horses, thus indicating that both affections were probably transmitted by the same species of ticks. One attack appears to confer immunity. Native animals from 1 to 2 years old were more susceptible than adults or very young animals.

The relative importance of these various gall-sicknesses would appear to depend upon whether the animals are native bred or imported, and upon the localities.

The author promises a series of reports on a number of investigations he has made upon this subject of piroplasmosis.

LEGER (A. & M.). **Piroplasme de la Civette au Senegal.** [A Piroplasm of the Civet Cat in Senegal.]—*Bull. Soc. Path. Exot.* 1920. Oct. Vol. 13. No. 8. pp. 649–652.

The authors describe a peculiar kind of small blood parasite in the Senegal civet cat (*Viverra civetta*). Blood was examined from two young animals freshly killed in the neighbourhood of Dakar. Both were infected and the parasites were classed as "rare" or "not rare." The parasite was rounded or regularly ovoid in shape and did not exceed 1 micron in diameter, often only 0·3 or 0·4 micron. The cytoplasm after staining with Giemsa or Leishman appeared azure blue and did not contain any trace of pigment. The nucleus was relatively very large and was situated peripherally, forming a bosselation which made up one-half or often two thirds of the circumference. It stained a deep garnet red colour. Sometimes a round chromatin granule could also be seen in the peripheral portion of the cytoplasm. The presence of two parasites within a single red corpuscle was only exceptionally noted. No rod-shaped element or parasite undergoing division could be seen and Maltese cross forms were entirely absent. No change was noted in the staining reaction or morphology

of the corpuscles. No appearances other than those seen in the peripheral blood could be seen in smears from the organs.

The intracorpuscular parasite belongs undoubtedly to the Family Piroplasmidae and among the Carnivora (carnivorous and insectivorous) several members of this family, belonging to five different genera, have been recorded.

(1) Genus *Piroplasma.*—Large haematozoa, often pear-shaped and dividing by a process of budding: *P. canis,* found widespread over the world in dogs.

(2) Genus *Smithia.*—Included by some authors in the preceding genus, multiplication characterised by division into four elements: *S. talpae* of the Jura mole.

(3) Genus *Achromaticus.*—Also characterised by large elements but gives rise to numerous intracorpuscular merozoites: *A. gibsoni* of the Madras jackal.

(4) Genus *Rangelia.*—Created by CARINI and MACIEL in 1914, elements rounded in shape and usually arranged in pairs; schizogony takes place in the cytoplasm of connective tissue or endothelial cells in the internal organs and produces a large number (30—100) of merozoites: *R. vitali* of Brazilian dogs.

(5) Genus *Nuttallia.*—With rounded or ovoid elements in the blood corpuscles differing from the above by their very small size and the multiplication forms, which are seen in the peripheral blood, assume a Maltese cross shape: *N. herpestidis* in the Portuguese and perhaps in the Indian ichneumon, and *N. ninense* in the Tunisian and Corsican hedgehogs.

The genus *Nuttallia* can be distinguished from the genera *Theileria* and *Gonderia* by the absence of rod-shaped forms in the blood.

The parasite of the civet cat is, therefore, placed in the genus *Nuttallia.* It does not seem to be identical with the Nutallia already described in Carnivora although it certainly resembles the piroplasm of the Portuguese carnivora, but it is smaller than this piroplasm and moreover no cross-shaped or other multiplication forms were found in the blood. It would be somewhat premature to create a division of the genus *Nuttallia* for this piroplasm and in the meantime the authors propose to call it *Nuttallia civettae.*

LAVERAN (A.). **La leishmaniose canine chez la Souris.** [Canine Leishmaniasis in the Mouse.]—*Bull. Soc. Path. Exot.* 1920. Oct. Vol. 13. No. 8. pp. 680–687.

In a previous communication Laveran described the development of the leishmaniases and in particular the virus of canine leishmaniasis in the white mouse. A striking analogy was found to exist between the affections produced in this small rodent by *Leishmania donovani* of man and leishmania of canine origin. It was also shown that there were certain differences between the affections produced by the virus of kala azar on the one hand and that of oriental sore on the other. These studies have been continued and in particular the effects of the canine type of infection upon mice have been examined. Variations in virulence of the canine leishmania were noted following upon repeated sub-inoculations into mice, and, moreover, certain signs were noted by means of which one could recognise in a mouse killed in apparent good health a few months after inoculation that there had been an infection followed by recovery.

The following list gives the number of successive infections and the number of failures to infect after 1, 2, 3, 4, 5, and 6 sub-inoculations in mice. The number of infections terminating in recovery were also noted. Ninety-two mice were used in all.

1*st Inoculation.*—Successfully infected, 17; failure, 1; recoveries, 7.

2*nd Sub-Inoculation.*—Successfully inoculated, 13; failures, 2; recoveries, 8.

3*rd Sub-Inoculation.*—Successfully inoculated, 16; failures, 3; recoveries, 8.

4*th Sub-Inoculation.*—Successfully inoculated, 19; failure, 0; recoveries, 15.

5*th Sub-Inoculation.*—Successfully inoculated, 14; failure, 1; recoveries, 9.

6*th Sub-Inoculation.*—Successfully inoculated, 6; failure, 0; recoveries, 5.

The number of failures varied but little with the number of successive sub-inoculations, but the number of recoveries varied a good deal. The percentage recoveries was 38·88 for the first, 53·3 for the second, 42 for the third, 78·9 for the fourth, 60 for the fifth, and 83·33 for the sixth sub-inoculation. This high proportion of recoveries after the sixth sub-inoculation led to the loss of the virus in the laboratory. It would, therefore, appear that the canine leishmania instead of increasing in virulence when passed through the bodies of mice becomes gradually diminished in virulence for this animal.

The author records ten observations in which mice killed while they were manifesting signs of illness were found more or less markedly infected, and further twelve observations in which mice that had shown undoubted signs of affection were killed after the symptoms had disappeared or diminished and in which recovery was noted.

In the case of the infected mice the spleen was found to be markedly enlarged. The average weight of the mouse was 30·9 gramme and of the spleen 0·87 gramme (maxima 1·20, 1·25, and 1·40 gramme). Leishmania in more or less considerable numbers were found in the liver, in the spleen, and in the bone marrow and more rarely in the testicles, but these glands were often observed to be somewhat atrophied, presenting to the naked-eye quite an appreciable diminution in size, and the spermatocytes in them had more or less completely disappeared. One of these mice showed only a few leishmania in the spleen although it was still markedly enlarged and the testicles were undergoing atrophy. It is claimed that this mouse was well on the road to recovery and represented a sort of transition stage between the first group of mice and the second.

The mice that had recovered when they were post-mortemed no longer revealed any leishmania, but as a rule it was easy to obtain information with regard to a pre-existing infection. In the first place enlargement of the spleen was noted during the lifetime of the mice, and this enlargement although decreased, persisted for a certain period after the leishmania had disappeared. In twelve such mice, weighing on an average 31·16 grammes, the average weight of the spleen was 0·36 gramme, that is to say, distinctly lower than that of the spleen of the infected mice, although it was still larger than normal (6–7 cgm.). In the second place the testicles were often found to be atrophied; they were sometimes reduced to about half their normal size, their parenchyma was soft and in smears stained by Giemsa spermatocytes were absent or only rarely found, and even

then they were often deformed. The testicular atrophy was sometimes more pronounced on one side than the other.

In the case of mice inoculated intraperitoneally with the virus of kala azar and post-mortemed after recovery, Laveran had previously noted that testicular atrophy was not a rare occurrence.

All his experiments were carried out on adult male white mice, which were inoculated intraperitoneally with an emulsion of triturated fragments of liver and of spleen (or of one of these organs only) obtained from mice inoculated with the canine virus. The mice were post-mortemed after a very variable interval subsequent to the inoculation (73 days to 25 months), and some of them, comprising the infected mice, were in very poor condition. These animals were killed before death would have naturally taken place, in order to obtain clear results post-mortem. From the mice killed during the course of the disease or after recovery smears were made from the liver, spleen, bone marrow, and testicles. These smears were fixed and stained with Giemsa and examined with regard to the presence or absence of leishmania, and in the case of the testicles in order to ascertain the condition of the spermatocytes.

PARROT (L.). **Spirochétose naturelle du Canard domestique.** [Naturally Occurring Spirochaetosis of the Domestic Duck.]—*Bull. Soc. Path. Exot.* 1920, Oct. Vol. 13, No. 8, pp. 647-648, With 1 fig.

Although certain avian spirochaetes, such as *Sp. anserina* Sakharoff, *Sp. gallinarum* Stephens and Christophers, have been experimentally transmitted to the duck, there does not appear to be on record any case of natural infection of this animal. Parrot describes its occurrence in ducks at MacMahon, Constantine, Algeria. The six ducks were kept in a fowl house together with one cock, six hens and 15 chickens, from three to four months old. One four-months-old duckling died after six days illness. The symptoms were dullness, loss of appetite, bile-stained diarrhoea, partial paralysis of the hind quarters. Post-mortem there was patchy fatty degeneration and hypertrophy of the liver, enlargement of the spleen, and the heart appeared pale and soft. Four days later another, three months old, duckling commenced to show the same symptoms. The blood was examined microscopically two days later and numerous spirochaetes were seen in it, 12 to 18 microns long, of variable shape, each with about 4 to 8 spiral turns, and occurring singly or in groups from 15 to 18 microns in diameter. Four days after the onset of symptoms the blood was again examined, but with negative result. The duckling recovered. A three months old chicken was inoculated into the breast muscles with ½ c.c. of the blood while it contained spirochaetes, but the chicken did not become infected. The other birds in the fowl house did not at any time before or subsequent to these dates show any signs of spirochaetosis, although numerous ticks, *Argas persicus*, could be found in the wood work. The author suggests that the causal organism be named *Spirochaeta anatis* if further observations demonstrate the existence of a special spirochaetosis of the domestic duck.

DISEASES DUE TO METAZOAN PARASITES.

PARROT (L.) & JOYEUX (Ch.). **Les cysticercoïdes de** *Tarentola mauritanica* **L. et les Ténias du chat.**—*Bull. Soc. Path. Exot.* 1920. Oct 13, Vol. 13, No. 8, pp. 687–695*.

LOPEZ NEYRA and MUNOS MEDINA have recently established the relationship between two cysticercoids of the gecko, *Tarentola mauritanica* L. and tapeworms of the cat. The present writers, working independently, are able to confirm these observations.

Dipylidium trinchesei Railliet, 1893. The first of the cysts in question has four rows of hooks, and is commonly found in the intestinal walls of *T. mauritanica* in Algeria. It has been described from Oran, from El Kantara, where 20 per cent. of the geckos were infested, and from Granada. This cyst has also been observed in *Lacerta agilis* L. and in *Seps chalcides* Dum. and Bib. The authors are also of the opinion that these cysts are identical with *Cysticercus acanthotetra* Parona, 1887, from the adder, *Zamenis viridiflavus* Wagl. It has been suggested by DIAMARE (1893) that this cyst is the larval stage of *D. trinchesei* of the cat. DIAMARE's suggestion was based largely on comparison of the larval and adult scolices.

Unfortunately there are certain objections to this view. MARCHI (1878) attempted to rear the adult from this cyst in the gecko, by experimental feeding to various animals. He fed cysts to a vulture and a cat without success. However, after feeding the cysts to an owl (*Strix noctua*) he was able to observe the commencing development of the adult tapeworms in the intestine of the bird when killed for examination some days subsequent to the feeding. This experiment would not appear to be conclusive, since a Dipylidium has never been reported from *Strix noctua*, and the only members of this genus known to occur in birds are *D. avicola* Fuhrmann, 1906, from a vulture (*Gyps Gobbi*) in South Africa, and *D. columbae* Fuhr. 1908, described from a poor preserved specimen taken from an Egyptian pigeon. It may be pointed out that MARCHI only observed the initial stages of development, and there is nothing to prove that the tapeworm would have reached maturity in the owl. LOPEZ NEYRA and MUNOS MEDINA also concluded that the cyst in question was the larval stage of *D. trinchesei*, but were unable to complete the life-cycle of the worm experimentally. They made a study of the epidemiology of this worm and concluded that the facts of distribution confirmed their hypothesis.

The present authors (1920) have recently published a description of a cyst having four rows of hooks found in *T. mauritanica*. They agree with DIAMARE that the cyst is that of a Dipylidium. Its structure is very simple. Often many parasites are enclosed within the one adventitious membrane. The characters of the scolex, and in particular the hooks, are dealt with later.

In spite of the experiment of MARCHI referred to above, these workers performed the following experiment with a view to confirming their hypothesis that this cyst was the larval stage of *D. trinchesei*.

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*Abstracted by Mr. R. DAUBNEY., M.Sc., M.R.C.V.S.

On the 9th May, 1920, three kittens of the same litter were fed the following :—

Kitten 1. 8 cysts from the liver of *T. mauritanica.*
„ 2. 12 cysts from the intestinal wall of the same gecko.
„ 3. 10 cysts from the mediastinal region of the same animal.

A fourth kitten of the same litter served as control.

The animals were killed in the following order :—

Kitten 1. 7 days after feeding. No cestodes in the intestine.
„ 2. 14 days after feeding. In the first 8 in. of small intestine were found 6 young cestodes.
„ 3. 22 days after feeding. About 30 older cestodes in the intestine.
„ 4. Killed on same day as kitten 3. No cestodes.

Two kittens out of three were successfully infected, whilst a control remained free.

Cursory examination of the cestodes showed that those in kitten 2, killed 14 days after feeding, had well-formed sexual organs in their posterior segments, but the uterine capsule was not yet developed.

The cestodes of kitten 3, killed 22 days after feeding, proved to be of two species. The first of these was similar to those found in kitten 2, and was represented by about 30 individuals, in the posterior segments of which ripe eggs were discernible. The second species had only a solitary representative. The last segments of this worm contained eggs in formation, but the hooklets of the embryos were not yet visible.

The first cestode was determined as *D. trinchesei* Railliet, 1893 (Diamare, 1892). The characters given by the Italian author were easily verifiable from the specimens in question, the length alone being different. The incompletely developed specimens of the present workers measured from 30 to 50 mm. in the fresh state, and had a mean length of about 20 mm. preserved in alcohol. The worms, which contained ripe eggs, were about 60 mm. long when fresh and 20–24 mm. in alcohol. In order to make a fair comparison of these figures with those of DIAMARE, one ought to know whether this worker measured his specimens in the fresh state or in preservative, a point upon which the Italian author's text throws no light. If the latter was the case, then the measurements of the present writers agree perfectly with those of DIAMARE. DIAMARE would appear to have collected *D. trinchesei* in the intestine of a cat in Naples. He also received specimens collected by PASQUALE in Egypt. The specimens from Egypt would be most certainly preserved. No difference between the length of the Neapolitan and the Egyptian specimens was remarked, so that it would seem that the material used was preserved in each case.

The hooks are arranged in four rows and number about 80, agreeing perfectly with those of *D. trinchesei* and those of the cysts from the gecko. Measured after HENRY's method for *T. solium*, they correspond closely with those of the cysts, and measured by the method employed by DIAMARE, the results are almost identical. The hooks have the characteristic rose-thorn shape of the Dipylidia.

The suckers are a little larger in the adult stage than in the larval forms, measuring 100–110μ in the former as against 96μ in the latter. The genital organs are exactly as described by DIAMARE. The vas deferens runs forward to the anterior portion of each segment, instead of describing a curve as in *D. caninum.* The vagina opens above the

cirrus sac (below in *D. caninum*). The ovaries are globular and unbranched, whilst the uterine capsules contain each only a single egg. These characters are peculiar to *D. trinchesei*.

The authors therefore conclude that the cysticercoids of *Tarentola mauritanica* are the larval stage of *D. trinchesei*. As it has been established that cats eat these animals in Algeria and Granada, it will be readily conceded that ample opportunity occurs for the completion of the life-cycle of this cestode.

On the other hand they consider that it is possible that *D. trinchesei* is not solely confined to the cat as a definitive host. The partial success of the experiment of MARCHI in the owl may indicate that the worm is capable of development in other hosts. Equally too, the fact that *Cysticercus acanthotetra* has been found in the adder *Zamenis viridiflavus* has to be explained. Since cats do not eat snakes, it is necessary to admit either that *T. mauritanica* is the intermediate host and that those cysts occurring in *Zamenis viridiflavus* are accidental and without chance of further development, or that *D. trinchesei* may also occur in snake-eating animals which are infected in eating *Z. viridiflavus*.

Dipylidium Chyzeri, Von Ratz, 1897.—The second cestode, which had only a single example in kitten 3, is more difficult to determine. It is again a Dipylidium and measures about 250 mm. in length in the fresh state, and about 175 mm. preserved. Its stage of development agrees well with what might be expected from the date of infection. The last segments contain eggs in process of formation, in which one is as yet unable to distinguish the six larval hooks.

The hooks of the rostellum are arranged in about 15 rows and are graduated in size. They are typical Dipylidium hooks, and smaller than those of *D. trinchesei*. In their dimensions they resemble those of *D. caninum*, but of course the number of the rows is much greater. The rostellum is almost completely evaginated, sub-cylindrical, and rounded at its anterior extremity, measuring 100μ in diameter at its base and being 130μ in length. The suckers are 135 to 140μ in diameter. The scolex is about 500μ in diameter in its thickest part. The neck is moderately developed. The segments resemble those of *D. caninum*, lengthening as they ripen. The two genital pores open in the anterior part of the segments.

The genital organs develop much later than in *D. trinchesei*. The cirrus is slender, retracted in its sac, which measures about 220μ by 100μ. The vas deferens passes forward into the anterior portion of the segment without describing any curve. Testes are numerous. The vagina opens in the neighbourhood of the cirrus pouch, descends towards the posterior part of the segment and ends in a coiled seminal receptacle. The ovaries are difficult to see in total mount, but on section they appear as two globular masses surrounding the receptaculum. The vitelline glands are small. The eggs in the posterior segments are only about 30μ in diameter, and their hooks are not yet evident. Each egg is contained in a separate uterine capsule.

The characters outlined would place the worm in the genus Dipylidium, and in that group of the genus which is characterised by numerous rows of hooks. Taken as a whole, these characteristics enable the authors to determine the worm as *D. Chyzeri*, Von Ratz, 1897, found in the cat in Budapesth.

SONSINO (1897) has described a cysticercoid from the gecko, having 14 rows of characteristic rose-thorn hooks. LOPEZ NEYRA and MUNOS

MEDINA have latterly given a more complete description of this cyst. They found this form readily in the geckos of Granada, and considered it to be the intermediate stage of *D. Chyzeri*. They were able to infect cats by feeding the viscera of geckos, accompanied by the usual controls, and in an epidemiological study of *D. Chyzeri* they recorded it from 15 per cent. of the cats examined. This would indicate that *D. Chyzeri* occurs in Algeria, Spain and Budapesth.

The experiments, then, taken as a whole, well explain half of the life cycle of *D. trinchesei* and *D. Chyzeri*. There remains to be completed the infection of geckos with the larval stage, by feeding the segments of the adult worm.

LOPEZ NEYRA and MUNOS MEDINA report that they have observed the commencement of larval development of *D. trinchesei* in the gecko. They show a slowness in their development which corresponds perhaps to the hibernation of the reptile host.

A bibliography is given.

PONS (R.). **Description de deux microfilaires sanguicoles, parasites d'un oiseau** (*Merganser serrator*) **vivant dans des régions froides (Terre-Neuve, Anticosti, Saint-Pierre et Miquelon).** [Two Microfilariae in the Blood of the Merganser, a Diving Bird or Sea Duck living in Cold Parts (Newfoundland and Neighbourhood).]—*Bull. Soc. Path. Exot.* 1920, Oct. Vol. 13, No. 8, pp. 652–654, With 2 figs.

The merganser, commonly called locally the sawbeak, is either a sedentary or migratory bird, living by the sea shore or on ponds of salt or fresh water inhabited during the months of August and September by numerous mosquito larvae. No adult forms of the filariae were observed.

The smaller of the two embryos, which the author calls *Microfilaria legeri*, was much the more common. It was found in the blood of five out of twelve water birds examined. This embryo was sheathless and in fresh preparations exhibited slow corkscrew and lashing movements. The anterior end was refractile and rounded and somewhat preputial in form, inasmuch as the axial part could be retracted or projected rapidly. This extremity sometimes became fixed to the slide while the rest of the body exhibited motility. A slightly attenuated posterior portion ended in a very refractile prominent point.

After staining with Giemsa the body of the parasite appeared somewhat stunted, about 100 to 105 microns long by 5·5 microns broad. The anterior extremity showed two elongated peripheral chromatic spots separated by a clear space, the caudal extremity was one-sixth the length of the embryo and terminated in a nuclear spot. Two somewhat indistinct rows of cells with large nuclei were seen in the body and their continuity was interrupted in a very characteristic manner: (*a*) Just in front of the middle of the embryo there was a rounded clear space, and (*b*) the commencement of the tail, that is, the posterior sixth, was occupied by a clear space, often clover-shaped, with each lobe occupying only a part of the thickness of the parasite, and (*c*) just in front of the end of the anterior quarter there was a triangular shaped clear spot. The parasite appeared to become bent at the level of these clear spots.

The second type of embryo was only encountered on one occasion and then in very small numbers in the right jugular vein and in

scrapings from the neck muscles. The embryo did not exist in the chest or abdominal blood. The embryo is called *Microfilaria guillemeti*. It was sheathless and in the fresh state it exhibited rapid wriggling movements. The rounded anterior extremity was more regularly narrowed down, commencing from the posterior fifth and terminating in a blunted point. After staining, the parasite measured 250–260 microns long and 6·5 microns broad. The anterior extremity possessed no nuclei over a distance of about 12 microns; the posterior extremity appeared clear on account of the loose arrangement of the circular chain and it terminated in a chromatin spot. The continuity of the chain of cells appeared interrupted in two or three parts, anteriorly one-third the length of the parasite from the anterior end and posteriorly about one-third from the posterior end.

CURASSON (G.). **Essai de traitement de la microfilariose du Charognard.** [Experiments in the Treatment of Microfilariasis of the Carrion Crow.]—*Bull. Soc. Path. Exot.* 1920. Oct. Vol. 13, No. 8. pp. 654–655.

Recently the author had occasion to note the presence of several adult and embryonic filariae of the domesticated and wild birds of Senegal. Some of them were obtained in sufficient numbers to undertake experiments in the treatment of the affection and in this note a short account is given of the results obtained with the carrion crow. Microfilariae were frequently found in these birds in the neighbourhood of Dakar, especially in those that lived on slaughter-house refuse. Out of 22 birds examined 14 harboured the parasites. There is every reason to think that the transmission of these parasites is easily accomplished either by the bites of the numerous mosquitos or by means of the ecto-parasites with which the birds are densely covered.

Three infected birds were treated with galyl, slowly injected in 1 per cent. solution, at the rate of $\frac{1}{2}$ c.c. per kilo body weight into the axillary vein. This treatment brought about at least partial recoveries.

One bird showed numerous parasites in the blood; two hours after the first injection they were still quite as numerous, but much less active. On the following day the bird was again injected and on the next day no parasites could be seen in the blood, which remained free for nine days subsequently. Afterwards, however, the microfilariae commenced to re-appear. The bird was post-mortemed on the following day but no adult worm was discoverable. The second bird showed numerous parasites in the blood and on the day following the first injection they were still as numerous and their vitality did not seem to be affected. On the second and third day further injections were given, and on the fourth day the parasites became rare and exhibited little activity. On the fifth day the bird died accidentally and on post-mortem two adult filariae were found dead in the abdomen. There were no males and in the heart and lung blood very few dead embryos were seen.

The third bird also showed numerous embryos in the blood when first injected. The injection was repeated on the second day and on the third day no parasites could be seen in the peripheral blood. The blood remained free subsequently for 12 days and the animal was then post-mortemed. One adult female, apparently dead, was found in the abdomen.

YORKE (Warrington) & MACFIE (J. W. S.). *Strongylidae* **in Horses.** ix. *Cylicostomum tridentatum* **sp.n.**; x. **On the Genus** *Poteriostomum*, **Quiel**; xi. **Species Found in West Africa and Jamaica**; xii. *Cylindropharynx rhodesiensis* **sp.n.**; xiii. *Cylicostomum triramosum* **sp.n.**—*Ann. Trop. Med. & Parasit.* 1920, Nov. 27. Vol. 14, No. 2, pp. 153–157, 5 text figs.; pp. 159–163, 6 text figs.; pp. 165–167, 2 text figs.; pp. 169–174, 7 text figs.; and pp. 175–179, 5 text figs.*

†ix. A new moderately small species of the genus *Cylicostomum* is described from the caecum and colon of a young mule in West Africa and from a horse in Jamaica. This species is characterised by the presence of three small chitinised triangular teeth, one dorsal and two ventro-lateral, corresponding to the divisions of the oesophagus and projecting into the base of the mouth capsule. It belongs to the "*catinatum-alveatum*" group and is considered by the authors to resemble most closely *Cylicostomum alveatum*. From the latter the new species may be distinguished by its smaller size, the projection of the dorsal gutter as a tubercle, the circular opening of the mouth capsule, and the presence of chitinised teeth mentioned above. A complete diagnosis of the species is given.

x. QUIEL in 1919 described a strongyle (*Poteriostomum imparidentatum*) from the caecum and colon of horses at Donchery, which, although closely resembling a cylicostome, differed from the members of that genus in certain respects. He erected a new genus *Poteriostomum* for this worm, basing it on the fact that six of the elements of the internal leaf-crown are larger than the remainder and distinctly different in shape, and also that there are no bosses on the posterior end of the female. QUIEL called this worm *P. imparidentatum*. It was shortly afterwards described from Dutch horses by IHLE, who also created a new genus for it and named it *Hexadontostomum markusi*, and by TURNER, who described it as *Cylichnostomum zebrae* from Chapman's zebra.

The present authors point out that the structure of the bursal rays which QUIEL figured, constitutes a much sounder generic character than the variation in the length of the internal leaf-crown elements referred to by that worker. The supporting rays form two distinct groups, a ventro-lateral and a dorsal. The externo-dorsal ray arises from a common trunk with the dorsal ray, the main trunk of the dorsal ray being split only for about half its length, and the two lateral branches arising close to the margin of the external rays. This arrangement differs remarkably from that found in any hitherto described species of the genus *Cylicostomum*. On account of similar structure of the bursal rays the authors transfer *Cylichnostomum ratzii*, Kotlan, 1919, to the genus *Poteriostomum*, although the elements of the internal leaf-crown are all of the same size and shape.

Accepting this generic diagnosis Yorke and Macfie include the following species in this genus—

Poteriostomum imparidentatum, Quiel, 1919. Syn. *Hexodontostomum markusi*, Ihle, 1920. *Cylichnostomum* zebrae, Turner, 1920. *Poteriostomum pluridentatum*, Quiel, 1919.

*For titles of previous papers of this series see this *Bulletin*, 1918. Vol. 6. pp. 135 & 269; and 1919. Vol. 7. pp. 115 & 281.

†Abstracted by Mr. R. DAUBNEY, M.Sc., M.R.C.V.S.

Poteriostomum ratzii (Kotlan, 1919), Yorke & Macfie, 1920. Syn. *Cylichnostomum ratzii*, Kotlan, 1919.

Possibly *Cylicostomum ultrajectinum*, Ihle, 1920, based on the description of a single female, should be included in this genus.

A key to the species of the genus is appended and the authors give a bibliography of the literature relating to these forms.

xi. This is a list of species found in horses and mules in the localities referred to.

A new variety of *Cylicostomum catinatum* is described from the caecum and colon of a horse in West Africa. The worm is identical with *C. catinatum*, with the exception of certain characters of the appendages of the genital cone. These appendages are long and finger-like in the new variety and the author's figure shows that they differ markedly from those of C. *catinatum* as figured by Looss. The authors propose the name *Cylicostomum catinatum* var. *litoraureum* for the new variety.

xii. A species of the genus *Cylindropharynx* from the large intestine of the zebra (*Equus burchelli*) shot in N. Rhodesia. This species is differentiated from the other two members of the genus mainly by its large size. It is roughly twice the length of either of the other species. There are, however, other minor differences and a key to the three species is given.

xiii. A new species from the intestine of a zebra (*Equus burchelli*) shot in N. Rhodesia. This is a medium-sized species closely resembling *Cylicostomum radiatum*, but distinguished from it by the prominence of the lateral head papillae, and by the dorsal ray being three branches. The genital appendages of the male are also different from those of *C. radiatum*. One male and one female only were found.

HODGKINS (J. R.). **Presence of** *Gastrophilus equi* **in the Dog.**— *Vet. Jl.* 1920, Nov. Vol. 76, No. 11. pp. 417–418.

While under treatment for paralysis of the hind quarters due to stercoremia three larvae of the above oestridae were vomited up by an eighteen months old terrier. Two of the larvae were mature, and one was much smaller. It was probable that they had been ingested by the dog, although there was no history of its having been fed with material that could have contained these larvae.

BACTERIAL DISEASES.

SHEATHER (A. L.). **Bovine Lymphangitis.**— *Jl. Comp. Path. & Therap.* 1920, Sept. Vol. 33, Pt. 3. pp. 158–185. With 10 figs.

The available literature on this subject is first reviewed. NOCARD (1888) examined specimens received in France from Guadeloupe and isolated from the pus and preserved tissues a streptothrix which was regarded as the causal organism. The disease was of a very chronic nature, starting on the limbs and spreading to the belly, with cording of the lymphatics and enlargement of the glands. The rabbit was resistant to inoculation. In the guinea-pig intraperitoneal or intravenous inoculation caused death in from 9 to 20 days and

produced lesions resembling those of miliary tuberculosis; subcutaneous inoculation led simply to abscess formation at the seat of inoculation with involvement of adjacent glands.

VRYBURG (1907) next studied a very chronic form of bovine lymphangitis in Sumatra, characterised by the development of abscesses in the skin, connective tissue, lymphatic vessels, and glands. Cases of the disease were usually sporadic but occasionally actual outbreaks were observed, which were spread out over long periods. From the pus a small Gram-negative bacillus was isolated in pure culture which was difficult to recognise in the pus on microscopic examination. Inoculation of cattle with cultures produced local lesions and abscess formation in the lymphatic glands and recovery took place in three months. Guinea pigs inoculated subcutaneously developed local abscesses in about three weeks. Intraperitoneal inoculation produced purulent orchitis and death in about two months.

Lymphangitis of cattle in India has been investigated by RAYMOND (1906—1909) and HOLMES (1907—1908), and it would appear that both these workers were dealing with the same outbreak. RAYMOND carried out his work with animals handed over to him for the purpose and HOLMES with materials taken by him in Calcutta and examined at the Muktesar Laboratory. The disease studied did not differ clinically in any material respect from that described by NOCARD and VRYBURG. In the majority of cases the infection originated from a wound of the neck or hump but in one case (as in most of NOCARD's cases) infection seemed to have gained access through a wound in the foot. The affected glands had thick fibrous capsules and in extreme cases the capsules were filled with thick yellow caseous pus and in other cases they contained a number of small encapsuled abscesses. In advanced cases these abscesses were found in the lungs and bronchial glands.

The results of these two workers' bacteriological examination were markedly discordant. HOLMES stated that in every specimen of pus he examined he found granules resembling those of actinomycosis. These masses when examined microsopically after staining by Gram or Gram-Weigert were found to consist of a dense collection of small cocci identical in appearance with the spores of actinomycosis, closely interwoven with thin branching filaments. Sheather maintains, however, that it is very difficult from HOLMES' description to get a clear idea of the appearance of the organism. Cultures were obtained in about 5 per cent. of the tubes inoculated and the cultivated organism resembled morphologically the organism found in the lesions. Guinea pigs inoculated subcutaneously with pus from lesions in cattle developed local abscesses only which showed no tendency to burst. Cultures made from these lesions and inoculated into "small animals" produced death in from 2 to 7 days. Two bulls inoculated subcutaneously and two intraperitoneally with pus emulsion failed to react but these animals were kept under observation for less than a month.

RAYMOND, on the other hand, after taking some trouble to exclude contamination, succeeded in isolating a small bacillus which he considered to be the cause of the disease. These stained by Gram-Weigert but not by Gram. It was non-motile, strictly aerobic, and grew slowly in artificial cultures. Five strains of the bacillus were isolated both direct from the natural lesions and after passage of the original pus through guinea-pigs, and the disease was reproduced in calves with the cultures obtained. Guinea-pigs inoculated almost

invariably showed suppurative orchitis and abscesses in the omentum and mesenteric glands.

The material used by Sheather in his investigations comprised specimens from four cases received from Madras (from WARE, F., Supt. C.V.D.): (1) Abscess removed surgically from hip of bull calf and two bottles of pus from the enlarged precrural gland; (2) pus from abscess on slaughter of six-year-old cow which had had suppuration of one precrural gland some time previously; (3) pus from prescapular gland of three-year-old bull; both prescapular and precrural glands had been opened previously, preserved left prescapular gland also received; (4) pus from abscess in left popliteal gland of five-year-old cow; pharyngeal and precrural glands from this animal were also enlarged and indurated. It seems that the materials from these cases, with the exception of Case (3), were contaminated on arrival. Numbers of rabbits, guinea-pigs, and cattle were inoculated with each of these products, with the exception of that from Case (2), which was heavily contaminated, immediately after they had been received; attempts to obtain the causal organism from the original pus were not considered satisfactory.

Rabbits proved refractory to the effects of inoculation. For example, eight rabbits, inoculated some subcutaneously and some intraperitoneally from Case (3), were kept under observation for six months and remained healthy during this period; swellings developing into local abscesses, which burst and healed, followed subcutaneous inoculation with material from Cases (1) and (4).

In guinea-pigs the most striking feature was the development of a purulent orchitis in a very large percentage of animals inoculated intraperitoneally. Slight local lesions developed in some of those inoculated subcutaneously.

Susceptible cattle inoculated subcutaneously developed a local lesion with involvement of the nearest lymphatic gland. Six hill bulls were inoculated from Case (1). These all developed local lesions with transient enlargement of the neighbouring prescapular gland. In only one of these animals was there evidence of persistent infection. For testing the materials from Cases (3) and (4) plains bulls were obtained specially, but it would appear that the resistance of these animals was about as great as that of the hill animals. The subcutaneous method of inoculation was the only method of infection employed for cattle.

A number of animal experiments were then carried out with materials other than the original specimens of pus. A broth culture was made from the testicular lesion of a guinea-pig inoculated intraperitoneally with pus from the first, original, case. Sub-cultures from this reproduced the same lesions upon inoculation into guinea-pigs.

Again, pus was withdrawn from the local abscesses that developed on the calves inoculated with material from Cases (3) and (4). The majority of these guinea-pigs developed a purulent orchitis. All the guinea-pigs inoculated intraperitoneally with culture derived from the pus withdrawn from the glands of two of these calves developed a purulent orchitis, together with abdominal lesions. Six calves inoculated with culture all developed more or less pronounced local lesions, with glandular involvement. The condition so produced resembled the natural disease in that the lesion developed very slowly and the suppurating glands showed little tendency to burst spontaneously. There was no rise of temperature and the animal showed no disturbance of health. Guinea-pigs again inoculated with culture derived

from the testicular lesion of a guinea-pig inoculated with pus from the local lesion of a calf developed purulent orchitis.

" From the constancy of the lesions produced with materials from both batches of specimens it would appear that the organism which has been isolated from both is actually the cause of the original disease."

Primary cultures, whether from natural or experimental lesions, grew slowly and were scanty. This is considered to be in agreement with the fact that it was generally impossible to discover the bacilli in the pus by means of the microscope, and with the escape from infection of a certain proportion of the animals inoculated. Serum-glycerine-broth appeared to be the best medium for primary culture and usually there is a considerable multiplication of the bacilli by the third or fourth day. The organism also grows in primary culture on serum-glycerine-agar, but growth is slow and usually not visible by the fourth day.

Sub-cultures in serum-broth or serum - glycerine - broth. After 4 days incubation, a small amount of white flocculent deposit was obtained at the bottom of the tubes only in from one-third to half the tubes inoculated: a coherent surface scum begins to form about the third day.

In primary cultures on serum-agar or serum-glycerine-agar the organism develops small round translucent colonies, colourless by transmitted light, and slightly whitish by reflected light. These colonies are generally invisible to the naked eye until after the second 24 hours. In sub-cultures the growth takes the form of a continuous layer, slightly yellowish by transmitted light and white by reflected light. On neutral red agar the growth acquires a strawberry pink colour. No growth on potato, milk not coagulated, no indol formation.

Stains by any of the simple aniline dyes, but not " fast " to Gram, Gram-Weigert or Claudius. Good preparations were obtained with diluted carbol-fuchsin, and carbol gentian violet, followed by 1 per cent. acetic acid, which could be left to act for a minute or more without appreciably decolourising the bacilli.

As regards morphology the organism as it occurred in the pus from natural lesions, where it was found after some difficulty in some cases took the form of a small bacillus occuring singly or in small groups. It measured from 2–5μ long by 0·3 to 0·6μ broad. The majority did not stain evenly; some showed a speck at each end with a colourless central part, while others presented a distinctly beaded appearance.

In culture the bacillus varied in shape according to the nature of the medium and age of the culture. In the sediment of a 24 hour broth culture it took the form of long filaments intricately twisted and coiled together. Some of these stained faintly and were only slightly beaded. In others the beading was distinct, while in others there was clear segmentation into bacilli. Even after 24 hours incubation what appeared to be involution forms were discoverable. Some of the filaments had rounded swollen ends and some of the bacilli were large and spindle-shaped. A portion of the culture was composed of separate bacilli resembling those found in the pus.

A 24 hour growth on serum-agar or serum-glycerine-agar consisted mostly of separate bacilli; a small number of filaments were usually discoverable, not more than 30–40μ in length. Individual bacilli varied considerably in size. Granular as distinct from beaded forms were sometimes found in these preparations.

After further incubation, changes in the morphology of the bacillus became very marked, and after 120 hours (in serum-broth culture) regular filaments had practically disappeared. The growth was then almost entirely composed of bacilli showing great variation in shape and size.

The organism described in the present paper is stated to agree in the majority of its characters with those described by VRYBURG and RAYMOND.

It would thus appear that there are at least two distinct forms of bovine lymphangitis, one caused by a streptothrix (NOCARD), and the other by a bacillus (VRYBURG, RAYMOND, and SHEATHER).

" The bacillus does not appear to agree in all its characters with any of the pus producing bacilli hitherto described [except that very little difference seems to exist between it and *Bacillus pyogenes*, which has been described as a frequent cause of suppuration in cattle and also in pigs, especially in America.—ED.] It approximates most closely to the Preisz-Nocard bacillus, but differs from that organism in being Gram-negative."

NÈGRE (L.) & BOQUET (A.). **Sérothérapie d'une Affection Mycosique Chronique. (Lymphangite épizootique des solipèdes.)** [Serum Therapy of Epizootic Lymphangitis.]—*Rev. Gén. Méd. Vét.* 1920. Sept. 15—Oct. 15. Vol. 29. Nos. 345–346. pp. 477–483.

These authors furnish still one more contribution to their already considerable study of this affection. In 1917 they carried out a few experiments upon treatment by means of an anti-yeast serum obtained by injecting a sheep with increasing doses of a non-pathogenic yeast (*Saccharomyces ellipsoideus*), [*see* this *Bulletin* 1919, Vol. 7, No. 2, p. 78.] The work was unfortunately interrupted, but some interesting results were obtained. However, one of the horses treated by the injection of large doses (40—80 c.c.) of this serum, repeated every two or three days, lost condition to such an extent after a week that it had to be slaughtered, although at first the lesions showed some improvement.

LATOUR recently has claimed to have had good results with a number of affected animals treated by means of serum obtained from the recovered horses. The number of recoveries were said to exceed 75 per cent., and large doses, 150 c.c. every four or five days, injected subcutaneously, were recommended.

The results obtained by Nègre and Boquet with anti-cryptococcic serum, published in this paper, do not confirm in their entirety the conclusions of this author. Indeed, they maintain that several years' work upon this affection has not yet enabled them to find out the heroic remedy, which some claim to have discovered so often. The authors had the advantage of being able to study the infection particularly well on account of the methods they have devised for cultivating the organism and so obtaining quantities of culture to work with. They claim nevertheless to have cured a satisfactory proportion of severely affected horses by means of so-called pyo-therapy and experiments in progress encouraged them to believe that an effective method of immunisation may yet be obtained. The results obtained during their work are, moreover, of considerable general interest.

Having at hand considerable quantities of culture they attempted to manufacture a specific anti-serum by hyperimmunising a horse.

The technique adopted was that employed by BORREL in the preparation of anti-sheep pox serum. A horse that had recovered from ulcerative lymphangitis but had never shown any symptom of epizootic lymphangitis was submitted over a period covering 118 days to 11 subcutaneous injections, first of small doses (0·05 gramme) of dead culture, ending up with large doses (4 grammes) of living culture. The horse was bled a fortnight after the last injection. The inoculations produced large swellings and abscesses which opened up in from the sixth to the tenth day and cicatrised in a few days after having discharged pus copiously. Each injection was followed by a thermal reaction which reached up to 30° C. when doses of 3 to 4 grammes were given. The fever commenced a few hours after the injection and lasted up to the end of the third day. During the course of the fever the animal's condition became markedly affected and it was dull, depressed, weak and had no appetite. Although the lesions of ulcerative lymphangitis had completely cicatrised increased pain and tenderness were noted on their site 24 to 48 hours after inoculation, but this disappeared very rapidly. On about the twenty-fourth day of the treatment the animal accidently developed a suppurative condition of the foot which disappeared, however, in two or three days.

Injections of large doses (25—40 c.c.) of the anti-serum thus obtained, repeated at intervals of from 24 to 48 hours into affected animals, brought about during the first few days of treatment an improvement followed by a distinct aggravation of the symptoms and lesions, which was manifested by the appearance of fresh ulcers and increase in the amount of suppuration. The serum tended to cause the rapid disappearance of the buds and set up to the same degree as the corresponding antigen, a marked inflammatory reaction at the seat of the lesions [*see* this *Bulletin* 1919. Vol. 7. No. 4, p. 228.] The serum, however, was quite incapable of arresting the course of the infection, which continued to progress.

Three horses that were very severely affected were treated by this means. One died during the treatment and the condition of the other two continued to become worse so that the injections were discontinued.

Inasmuch as the serum acted very much in the same way as antigen the treatment was modified somewhat on the remaining two horses. Small increasing doses were employed instead of the large doses and injected intravenously instead of subcutaneously. One of the two animals which had been affected for several months showed extensive lesions in the form of large ulcers causing total loss of skin over the right hind leg and it showed symptoms of general intoxication due to the invasion of the exposed parts with secondary organisms. It was killed on the point of death, after three weeks of fruitless attempts at treatment.

The third horse had been affected for nearly 10 months and showed generalised lesions that were continually extending. All methods of treatment had failed, and the horse was deemed to be incurable, when it was submitted to the following treatment. First day 1 c.c., second day 2 c.c., fourth day 5 c.c., eight day 10 c.c., fifteenth day 12 c.c., twenty-fifth day 12 c.c., and thirty-second day 15 c.c., intravenously. During the first 24 hours after injection there was increased suppuration, and fresh buds appeared which developed a fluctuating consistency after 24 hours and discharged. After the third day the indurated mass, of about the size of a fist situated

on the side of the neck, and the corded lymphatics commenced to disappear. The cryptococci disappeared gradually from the pus, and cicatrisation of ulcers which were several months old took place with surprising rapidity. Six weeks after the commencement of treatment the horse was in excellent general condition; there was almost no suppuration, small ulcers 1 to 2 cm. in diameter became cicatrised, and large granulating areas, about the size of the hand, showed a clean surface which was being gradually covered over with epidermis.

Although numerous methods have been tried by the authors, none appear to have been so encouraging as this method. They compare the focal reactions obtained, after the injection of serum in this condition, with those already remarked upon by LAVERDE and CARRASQUILLA in the treatment of leprosy by means of the specific serum. METCHNIKOFF and BESREDKA studied these phenomena and found that the results were not due to the products formed by the leprosy bacillus in the sera but to the cytotoxins contained in these sera.

CURASSON (G.). **Au sujet du traitement de la lymphangite épizootique.** [Treatment of Epizootic Lymphangitis.]—*Bull. Soc. Path. Exot.* 1920. Oct. Vol. 13, No. 8. pp. 640–644.

The writer claims to have had considerable experience in the treatment of this disease in Morocco, in France during the war, and in French West Africa, and in this short article he summarises the results obtained in his hands after employing the various recognised methods of treatment.

Cauterisation.—This old method appears to have given the best results, whether employed to open and cauterise the buds or to excise the corded lymphatics. It has certain disadvantages especially inasmuch as a good deal of damage may be caused to the tissues when lesions of considerable extent have to be dealt with, or when they are situated immediately overlying a bone.

Potassium Iodide.—This appears also to have given excellent results, but treatment is often very prolonged and costly. After having phlebitis set up in two cases as a result of treatment the author has now abandoned the method.

Galyl.—This drug was used in about ten cases in the same dose as recommended by DOUVILLE and his co-workers. Out of two severe cases one recovered after three injections without any local treatment other than opening up and cleansing the buds; the second case developed a generalised infection. All the other cases appear to owe their recovery more to the application of the cautery; this was adopted after the second injection inasmuch as no improvement seemed to have taken place.

Pyotherapy.—Pyo-vaccine, made up in the manner described by VELU [see this *Bulletin* 1918. Vol. 6, No. 1, p. 14.] was employed in 14 cases, a number adjudged to be insufficient to form a just estimation of its effects. However, the author seems to think that the surgical or medical treatment, which is always applied simultaneously, acts quite as effectively by itself. Perhaps, he thinks, this may be attributable to the fact that his cases were treated in the French Soudan or Senegal, where the disease appears to run a special course.

Biniodide of Mercury.—KAYSER specially recommends intramuscular injections of biniodide of mercury (dissolved in a solution of potassium

iodide and injected into the muscles of the croup), while at the same time the abscesses are opened and cleansed and sprinkled with powdered biniodide. The treatment would appear to give good results even during the rainy season. The author tested this mode of treatment by taking four horses showing lesions of about the same degree of severity, and injecting two of them with the biniodide solution while the other two were treated simply by the local application of biniodide. After an interval of ten days the latter two horses showed appreciable improvement and gradually recovered. The former two horses, after ten injections covering a period of a month, remained in the same condition. This would indicate that the biniodide is effective when applied locally, but of no account when injected intramuscularly.

Sodium Hypochlorite.—In three cases in which the lesions affected the lower parts of the limbs Dakin's solution was applied by continuous irrigation. The treatment was abandoned in from 15 to 18 days, on account of its inefficacy.

Perchloride of Iron.—On account of the encouraging results obtained in human medicine in the treatment of skin lesions, showing similar appearances, the author experimented with this drug upon four recently affected cases. The treatment resolved itself in fact into a cauterisation, which is less severe than that obtained by the actual cautery. The buds were opened and cleansed, and the walls rubbed with a piece of cotton wool soaked in the officinal solution. A brownish crust formed which at first was very adherent, but became detached on the second and third day owing to the formation of pus underneath it. After the third or fourth application the cavity changed in appearance, and its walls became finely granulating, smooth and regular. The treatment, it is said, can be left off at this point and the cavity cleansed simply in the ordinary manner, after which it rapidly becomes cicatrised.

Mercuric Iodide in the Nascent State.—After opening up and cleansing the lesion the cavity is rubbed over with tincture of iodine, a thin layer of double mercury ointment applied, and again rubbed over with tincture of iodine. Mercuric iodide in the nascent state is thus formed which acts as an antiseptic and counter-irritant. This method was utilised in about ten cases of moderate severity; it failed in four cases.

Some native methods of treatment.—Some of these are worth considering. The Bambara tribe wash out the opened abscess with an astringent decoction made from the leaves of a plant known as Sahe (a shrub of the leguminosæ order) and then apply a blistering ointment made from a mixture of butter and spice obtained from the latex of the large Euphorbia, or of *Calotropis procera* or *gigantea*, or even the dried-up and powdered leaves of these plants. At other times the latex is simply mixed with milk.

A red-hot iron is largely employed. In the Sahel district the Moors cleanse the lesions with fermented camel urine, which being strongly ammoniacal is a good detergent, and then apply a mixture of salt and crushed onions, or butter and natron. They also often employ the hot iron treatment. In the southern part of the district they use with some degree of success a powder obtained by crushing blue antimony salt, which is found in certain mountains in the Nioro area.

The Toucouleurs tribe recognise the disease as being contagious, and isolate the affected animal and treat it by the application of the hot iron and hyena manure.

In Senegal the natives utilise sea baths and highly astringent preparations, such as the powdered bark of species of lemon tree.

DUBOIS (Charles). **Essai de vaccinations simultanées chez le mouton contre le charbon et la clavelée.** [Vaccination of Sheep against Anthrax and Sheep-pox simultaneously.]—*Rev. Gén. Méd. Vet.* 1920. Sept. 15—Oct. 15. Vol. 29. Nos. 345-346, pp. 483-416.

The author's observations were made in the south of France in a district where apparently it is necessary to vaccinate sheep against both the above affections. Usually the two operations are performed one after the other, and an interval of several months is allowed to elapse between them. It would be an obvious advantage if these two operations could be performed at the same time. Sheep were taken from a farm where neither sheep-pox nor anthrax had been observed, and they were of a breed known to be highly susceptible to both diseases. The sensitised anti-sheep-pox vaccine of the Pasteur Institute of Algiers and the anti-anthrax vaccine of the Pasteur Institute, Paris, were employed. Six sheep each received simultaneously (1) inside the thigh, $\frac{1}{8}$th c.c. of a first anti-anthrax vaccine; (2) just behind the elbow, $\frac{1}{8}$th c.c. of the sheep-pox vaccine. Besides these, two sheep were inoculated, one with sheep-pox vaccine alone and the other with first anti-anthrax vaccine alone. The six sheep treated with both vaccines and the control sheep treated with sheep-pox vaccine alone showed, during the next few days, local and general reactions similar to those usually seen after sheep-pox vaccination has been undertaken alone. Eleven days after the first inoculation the anthrax vaccination was repeated, using the second Pasteur vaccine. At this time the animals were all in a satisfactory state of health.

Thirty-six days after the first injection the author endeavoured to find out whether there were any specific sensitising substances in the bloods of the inoculated animals. The control sheep treated with anthrax vaccines alone showed distinct though not complete deviation of the complement. The control sheep treated with sheep-pox vaccine showed marked deviation (presumably with sheep-pox material as antigen), and the sheep treated simultaneously with both anti-anthrax and anti-sheep-pox vaccines gave a positive, though slight, reaction towards sheep-pox and a more marked one towards anthrax culture.

The animals were then tested as to their immunity against sheep-pox. Forty days after the vaccination the skin of the chest was shaved and scarified, and sheep-pox material from an affected animal was applied. The six sheep that had been vaccinated with both vaccines and the sheep vaccinated with sheep-pox vaccine alone remained quite healthy. On the other hand, two sheep that had not been vaccinated, but were of the same age, breed and origin as the vaccinated ones, became affected with a very severe generalised form of sheep-pox, and one of them died.

The vaccinated animals were next tested as regards their resistance towards anthrax. 2 c.c. of a three-day broth culture, certainly fatal for susceptible sheep, were inoculated subcutaneously, 44 days after the injection of the second anthrax vaccine. Two control sheep, as before, were inoculated, and they died in three and six days respectively. The control sheep vaccinated against anthrax only

likewise died in five days, indicating, it is said, that the test inoculation was excessively severe. Out of the six sheep vaccinated against the two diseases one only succumbed to anthrax, after six days. The other five remained healthy.

These results would appear to indicate that animals can be satisfactorily immunised simultaneously against the two different affections. [A conclusion which has certainly not the merit of novelty—Ed.]

DISEASES DUE TO FILTERABLE VIRUSES.

Revue Générale de Médecine Vétérinaire. 1920, Nov. 15. Vol. 29. No. 347, pp. 577-583. **La Peste Bovine en Belgique.** [Rinderpest in Belgium.]

Rinderpest, which had not appeared in Western Europe since 1870, was inadvertently discovered in Belgium at the beginning of the month of August, 1920. The French Government learnt indirectly that several suspected centres had come to notice during the month of July, and inquiry revealed the following facts. At the end of June a cargo of zebus was dispatched from British India and touched at Antwerp on its way to Rio de Janeiro. The animals were unloaded in order to be transhipped into another vessel, and in the meantime were placed in quarantine depots. Several died, but it seems that no post-mortem examination was made; and at all events rinderpest was not suspected in spite of the origin of the cargo. The survivors were shipped on the 6th July, and sailed for Lisbon and Rio de Janeiro. On the 30th June and the 3rd and 6th July three cattle boats sent from Baltimore and New York for the feeding of the Belgian population also disembarked at Antwerp. The animals were all destined for immediate human consumption, and were almost all immediately placed on rail to be sent to the slaughterhouses. A few hundred only remained for one or two days in the quarantine depots, which were probably not disinfected. Infected animals were thus despatched to various distributing centres, such as Ghent and Namur, but the majority of these were slaughtered immediately, before symptoms were manifested. However, the slaughter of a few small lots was deferred, and among these the first cases of rinderpest appeared. Towards the 10th July, out of 94 oxen received at the Ghent abattoir, 17 affected ones had to be urgently slaughtered, while three more succumbed. The same occurrences were noted at Anderlecht and Namur, but up to this point, however, the malady had only appeared in the slaughterhouse; both sick and affected animals were destined for slaughter, and naturally the affected ones were hurriedly killed. Probably the danger would have disappeared before its presence had been suspected if one unfortunate incident had not supervened. Whilst the disease was breaking out in the Ghent abattoir a batch of cattle sent by the Germans for reparation was unloaded for distribution, and some of these animals became infected. These infected animals were scattered throughout the country, and it was by this means that the disease was spread.

Attention had been drawn to the severe forms of illness observed, especially at Ghent, but rinderpest was not suspected. No case had

been noted at Antwerp, where the cattle had remained for some time, and it was only later that the zebus were suspected. It seems that the first suspected cases were attributed to a malignant form of foot-and-mouth disease, and it was only about the 20th July that rinderpest was incriminated. A Commission composed of BORDET, GRÁTIA and LIÉNAUX investigated the disease; cattle inoculated with filtered urine and then with blood developed typical symptoms and lesions of rinderpest and died. The French Authorities became informed indirectly of the above facts on the 5th August, and the frontier was closed against importation of animals and animal products on that day, and appropriate sanitary police measures were organised along the frontier. On the 6th August the Belgian Ministry of Agriculture had cognisance of 40 separate centres of the disease. The situation became very serious; the disease spread very slowly, but it was found that it might assume quite a different character after a preliminary period for acclimatisation. Besides, it was anticipated that the disease might possibly be introduced indirectly on account of the large amount of commercial traffic across the frontier. Not only was it necessary to adopt measures on the frontier, it was also necessary to form a wide protective zone along the frontier. A census was taken of all cattle, sheep and goats throughout this zone and all movements of animals were forbidden, except when they were destined for immediate slaughter.

The French Government then arranged with the Belgian Ministry of Agriculture for the installation of a Serum Station at Brussels, and a considerable sum of money was voted for this purpose. This Station was located in one of the annexes of the Veterinary School at Cureghem, and its operations were supervised by NICOLAS and RINJARD. Not only did the French Commission succeed in producing in two months a sufficient quantity of serum, but it also obtained experimental results of considerable importance. Its work was followed by Commissions from other European countries.

The course of the Belgian outbreak presented some very interesting features. During the first fortnight of August fresh outbreaks were noted on an average on ten farms each day. By the 15th August 58 communes and 130 farms were reported affected, and 1,068 cattle had died or were slaughtered. From this time onwards the progress of the disease became retarded. From the 16th to the 31st, 69 more farms were found to be infected in all, that is, slightly over four per day. During September the state of affairs showed continued improvement; 25 more farms were found to be affected during the first fortnight. An invasion into French territory was feared as it was possible for the disease to extend from the centres situated near the frontier. One case in fact was suspected in the Lille district, but investigation proved that it was merely a typical form of malignant catarrh. In October the improvement became still more marked and four centres only remained in Belgium. On the 18th October the severe preventive measures ordained in France were largely relaxed. It was thereafter hoped that the plague would be limited to Belgium and that France would escape.

The most recent centre of the disease was detected near Liège on 16th November. [From that date up to 15th December no further case of the disease was observed.—ED.] At all events a sufficient supply of serum is at hand to limit losses from the disease and arrest its spread from primary centres of infection. The Belgian Sanitary

Service expressed from the commencement an optimism which subsequent events have justified. The measures undertaken consisted in rigorous isolation of the infected farms with slaughter of all affected and in-contact animals; burial after superficial disinfection of the infected and in-contacts showing fever; despatch to cold storage and for human consumption of meat from in-contacts exhibiting no fever, and thorough disinfection of the affected place. Moreover, enquiry revealed that the creation of new centres was ascribable in nearly every instance to the accidental or fraudulent movement of in-contact animals, and in a few other cases to the transportation of fresh meat. On the other hand none of them could be attributed to the very indirect modes of contagion described in all the classical references. Living intermediaries such as man or insusceptible animals played quite an insignificant or no part. Some exact observations showed that flies do not transport the virus.

The comparative mildness of the disease in Belgium is then discussed. The first theory that comes to mind is that the virus, departing from the zebu, an animal which is normally very resistant, was attenuated and only slightly virulent. This view, however, would seem to be controverted for two reasons. In the first place successive passages accidentally brought about by in-contact animals did not determine any aggravation in the epizootiological character of the outbreak; on the contrary the progress of the disease became regularly less and less. Secondly, experimental inoculation of the virus obtained from the first affected animals set up rapidly fatal types of disease which ended within the minimum periods usually accepted. It would appear that rinderpest is not nearly so formidable as one was at one time inclined to think it to be. Four more outbreaks were observed, almost without exception subsequent to military campaigns or in countries where the adoption of sanitary measures is met with difficulties of various kinds. The rapid diffusion of the disease in countries subjected to an enemy invasion is readily understandable as the disease is disseminated by the uncontrolled movement of animals, while the progressive invasion of a country where sanitary measures become difficult or impossible to apply may be explained in the same way. The persistence of the disease in Egypt and India and the outbreaks on the African Continent are easily explained.

On the other hand, rinderpest can be effectively combated among nations that possess a suitable and sufficient sanitary organization. The 1865 outbreak was stamped out without much difficulty in the north of France by the adoption of well planned, though improvised, measures. The spread of the disease in England at that time can be attributed to the total absence of a co-ordinated sanitary service. It is stated that the experience gained in this 1920 European outbreak is re-assuring, for it demonstrates the absolute efficacy of the classical methods of prevention in a country that possesses a veterinary organisation. Nevertheless, the terror inspired by the plague among the human population is a potent factor, for thereby severe measures can be framed without much resistance, as the interested parties become aroused to such a degree by the fear of contagion that one here obtains their collaboration—a condition which is indispensable for any mode of intervention to be effective.

MISCELLANEOUS.

CURSON (H. H.). **Saria.**—*Vet. Jl.* 1920. Nov. Vol. 76. No. 11. pp. 405-412. With 3 figs.

Saria is a name applied by the Wankonde, that is, the natives of Unkonde, the country situated at the northern end of Lake Nyassa, in the district of New Langenburg, to a peculiar chronic eczematous condition affecting their cattle, apparently different in many respects from other forms of tropical dermatitis. In the affected region the cattle are usually taken out to graze early in the morning and are brought back to be milked at midday. They then return to the veld and are fetched back again in the evening. At night they are housed in the same dwelling as the owner, who takes great care of his stock, providing bedding for them during the wet season, bringing them in during a storm, and usually pulling ticks off their bodies.

The cause of the disease was not definitely ascertained; cocci, and in a few cases, organisms resembling the necrosis bacillus, were seen in the serous exudate and affected skin area. Cattle with unpigmented skin seemed predisposed to attack, but calves and young stock up to three years old were seldom seen affected. Bulls also seemed to be very rarely attacked. It is noted that the affected cattle were kept at nights in smoke-filled houses. A large number of cattle belonging to other tribes, such as the Wanyika, who kept their cattle out of doors, were examined and were found not attacked. The condition also seems to be associated with good milking characteristics, and the natives even seem to exhibit a preference for Saria animals on this account.

The author quotes as examples of dermatitis affecting non-pigmented skin the following :—

(*a*) Extreme heat of the sun, which is said to cause dermatitis in white pigs in the Karroo. However, the Saria districts are situated at a fairly high altitude, 1,700-5,000 ft., and the climate is said to be temperate and more pleasant than in parts of the Karroo.

(*b*) Fagopyrismus or buckwheat poisoning.

(*c*) Trefoil dermatitis. [See this *Bulletin*, 1916, Vol. 4, No. 2, p. 73].

(*d*) Clover dermatitis.

(*e*) St. John's Wort dermatitis. [See this *Bulletin*, 1920, Vol. 8, No. 3, p. 258].

(*f*) Geeldikkop in sheep in South Africa [see this *Bulletin*, 1920, Vol. 8, No. 4, p 338].

(*g*) Vuurziekte (Dutch for fire sickness) a dermatitis affecting sheep, goats, or cattle in South Africa when in poor condition and suffering from wire worm infection.

The Unkonde veld was " sweet " and contained a large proportion of leguminous plants, including trefoil and lucerne, together with some species of dock, but these appeared to be never eaten. The neighbouring Unyaka and Ukinga veld was very similar, but the Unkonde veld is exposed to a much heavier rainfall, exceeding 100 inches a year.

In an animal from the highlands (Malila Plateau) the first symptoms is an erythema usually affecting the hump at its posterior and lower aspect, but also seen at times at the middle of the back. As it is only unpigmented skin that is involved, redness is very marked. The disease then spreads from the top or back of the hump down to

the sides or along the shoulders, flanks, or quarters. After some time the coat may become very thin owing to the shedding of hairs, or minute drops of serous exudate appear which mat several hairs together and a crust is formed, which if pulled or rubbed away causes the hairs to shed, often leaving small raw patches. These patches again become covered with a thin dark brown scab, and in time this scab is shed leaving a dark brown scar. Sometimes the condition remains localised and a thickening of the skin is produced and the hairs, that remain are short and do not lie flat. The skin becomes very sensitive to injury. The condition may spread along to the unpigmented areas. Poor condition does not seem to aggravate the disease, and the milk yield is not reduced and death does not result even from a general infection.

In many cases the irritation was not so severe as, for example, in cattle from the Lake Shore, Ipiana. The inflammation subsides, serum no longer exudes and new hair makes its appearance, but the skin remains thickened. Cases of the disease can be seen at all times of the year. It does not appear to be at all contagious, for healthy animals may be housed for years with affected ones without developing the lesions. It could not be transmitted by rubbing serous exudate and scrapings from infected ones on to healthy animals. It did not appear to be hereditary. As a rule about 5 per cent. of the cattle were affected, in any part of the country—Lake Shore or Highlands.

The author attempts to differentiate the condition from other recorded forms of tropical dermatitis. VAN SACEGHÉM described a dermatitis due to a streptothrix organism, which he named the *Dermatophilus congolensis*. In the Congo condition the disease was characterised by the formation of crusts over which the hair stood erect. This appeared to be the same with Saria. It was, moreover, characterised by its rapid spread, no predisposition as regards age and it was acute only during the wet seasons. In these respects it differs from Saria. Moreover, the Congo disease was said to attack black pigmented skin also. ARMFIELD (1918), in Northern Rhodesia, described a condition in which there were numerous wart-like processes, about $\frac{1}{4}$ in. in diameter, and when these were pulled off small hollows were left in the skin. Clean animals herded for several weeks with diseased ones were likewise said to become affected. In Saria scabs are only seen as the result of removing parts of the skin by blows or injuries and wart-like growths are not seen. In demodectic mange there are nodules in the skin, and if the contents are examined microscopically it is usually possible to find *Demodex folliculorum*. The skin lesions of rinderpest are present a long while after other symptoms of this disease have ceased, but the intense scouring leaves the animal weak and emaciated. The lesions which in severe cases take the form of ulcers around which the hair sheds may extend all over the head, neck, trunk and limbs. When scabs form the skin may become dry and parchment-like.

It is of interest to note that HORNBY has also recently described a peculiar skin disease in cattle in this region, viz., contagious impetigo of cattle in Northern Rhodesia. He, however, attributed the condition to the streptothrix first described by VAN SACEGHEM and, moreover the disease was said to be essentially seasonal in character and fresh cases were seen at the commencement of the rainy season, but after the end of the rains the disease assumed a chronic form in the survivors. [See this *Bulletin*, 1920, Vol. 8, No. 3, p. 232.]

CURSON (H. H.). **Chronic Laminitis of Cattle.**—*Vet. Jl.* 1920, Nov. Vol. 76, No. 11, pp. 418-419.

The author noted this condition while at work with the South African Rinderpest Commission on the border between the German East Africa and Northern Rhodesia and Nyasaland in May, 1918. A native brought in eight cattle to one of the Inoculation Stations (Mbosi); these animals had travelled a distance of about 40 to 50 miles. Two were old cows, three young cows, one was a yearling bull, and two were calves about four to six months old. The five oldest animals were suffering from laminitis, while the bull and two calves were quite normal. It was ascertained that the two old cows had been affected in this manner for many years, whereas the young cows (about four to five years old) had only developed symptoms within the preceding two years. It had taken 3½ days for these cattle to cover the distance, and it seemed that other cattle in the district where these had come from inevitably developed the condition when they became older. The condition would appear to be identical in appearance with the so-called "stijfziekte" of South Africa, which was proved by THEILER to be caused by eating a leguminous plant known as *Crotalaria burkeana*.

REPORTS.

GOLD COAST. **Report on Live Stock Industries of the Northern Territories.** MS. Report from the Veterinary Officer. [BEAL (W. P. B.).] Dated 27th May, 1920. 97 pp. f'cap. With 7 Appendices, comprising 4 Maps. [Report received from the Colonial Office, 28th October, 1920.]

In this report Beal submits an account of the present-day conditions of rearing live stock in the Northern Territories of the Gold Coast, and suggests measures by means of which the future of this industry might be improved and greatly increased. As compared with other great stock-raising countries situated outside the tropical zone the region under consideration cannot be said to be an ideal one. But, under certain conditions, it is more fortunately situated, for example, than Australia. In no district of the Northern Territories is there a genuine water famine; water can usually be obtained by travelling a short distance. Again, in certain parts of South Africa, *e.g.*, North-Eastern Rhodesia, Zululand, trypanosomiasis causes great havoc. In the Northern Territories reports to this effect have not been received, for although tsetse flies are to be found they are confined chiefly to the river system. Horse sickness and East Coast fever in cattle also cause ravages in the southern portion of the African Continent, but in the country under consideration these diseases have not yet been met with. The country, however, has suffered from severe epizootics, the principal one being the outbreak of contagious bovine pleuro-pneumonia in 1912–1913, and rinderpest in 1916–1917. These outbreaks, however, are not considered to have been so virulent as those experienced elsewhere. Having these points in mind the author contends that the Northern Territories are no worse off than any of the other live stock countries in the tropical zone.

Division and Administration. The area of the Northern Territories Protectorate is estimated at 36,000 sq. miles of unfenced land, with a population of 361,800 (10 to the sq. mile). It is divided into three Provinces for administrative purposes: (1) North-Eastern Province; (2) North-Western Province; (3) Southern Province.

(1) The North-Eastern Province has its Administrative Headquarters at Gambaga, and is sub-divided into four Districts: (*a*) Navarro District, controlling the Kanjarga and a portion of the Grunshi people; (*b*) Zouarragu District, ruling the Nankassi and Nankani peoples and the Fra Fra tribes; (*c*) Bawku District, ruling the Kussassi people; (*d*) Gambaga District, ruling the Mamprusi tribe. The paramount Chief, or the overlord of the tribes of this Province, is the Na of the Mamprusi.

(2) The North-Western Province has its Provincial Headquarters at Wa, and is sub-divided into three Districts: (*a*) Tumu District, ruling the Sissala, Grunshi, and the Komma people; (*b*) the Lorha District, controlling the Lobi tribe; (*c*) the Wa District, ruling the Wala and Dagarti tribes. The paramount Chief of the tribes of this Province is the King of Wa.

(3) The Southern Province has its Provincial Headquarters at Tamale, and is sub-divided into four Districts: (*a*) Tamale District, ruling the Dagomna tribe and the Daboyas; (*b*) Salaga District, ruling the Gonjas; (*c*) Yeji District, ruling the Brumasi people and the Brongs; (*d*) the Bole District, ruling the Boles.

Live stock, comprising cattle, horses, donkeys, sheep, goats, and poultry, are bred by all the tribes, in some places on a large and at others on a small scale. The only exceptions are the Brongs and Daboyas, who only breed sheep, goats, and poultry.

Physical Conditions. The land in the south is low-lying, and gradually rises by undulating plains to the centre, where these plains emerge into the plateau of the northern country, and then ends in the hilly country of the Tumu, Zouarragu and Bawku Districts. The two principal rivers are the White and Black Volta, which flow south.

The Black Volta forms the western boundary of the Northern Territories, separating it from the French possession of the Ivory Coast. At 8° 40′ north it enters the Gold Coast, and then flows east, forming the southern boundary of the Territories and separating them from Ashanti. It receives a few tributaries from this country and empties itself into the White Volta.

The White Volta is the chief river of the Protectorate and has many large tributaries, the chief of which are the Red Volta, the Kulpawn and Sissili Rivers, Nasia, Black Volta, and Dakar Rivers, all of which contain water throughout the year.

The best watered parts of the Territories lie between long. 0°–2° W., and Lat. 10°–11° N.

Average temperatures registered at Tamale were solar maximum 145, shade max. 95, shade min. 59, range 35, mean 77. Degree of humidity 55.

The average rainfall varies from 30 to 60 inches. The degree of humidity in the south is greater than that of the north and is said to run from 40 to 60.

The rainy season lasts from May to October, but July, August, and September are the chief months for rains. The dry season runs from November to April; the months of the Harmattan season, due to a wind blowing slightly west of north from the Sahara, are January

and February. During this season the days are hot, and the nights cold. The climatic conditions of the Northern Territories in their bearing upon development of live stock, therefore, show a relatively high solar maximum point, but a mean of 77°, two seasons, three months of heavy rain, three months of showers, and six months of dry weather.

Origin of the Present-day Live Stock. Cattle, sheep, goats, horses, and donkeys are believed to be of recent introduction. The Central and West African tribes used to be cannibals, and it is generally considered that cannibalism is not practised when meat is obtainable, especially the meat of cattle, sheep, and goats. Moreover, no aboriginal races practice stock raising, and therefore it would be difficult to assume the existence of an indigenous breed of cattle, sheep, and goats. The only tribes which raise live stock are the Peuhlish people, and the descendants of Peuhlish marriages and the Peuhls themselves are immigrants from foreign parts, having been descended from an intermixing of Arabs with Negroid races. These people and their descendants in their advance westwards, certainly introduced the zebu ox, the present-day breeds of sheep and goats, the horse and donkey. But the Taurine type of cattle found in the Territories is believed to be of a different origin (see later).

Present-day Methods in Vogue for Rearing Live Stock. As practised by the natives these are crude and unsatisfactory to the last degree, everything being left to chance. There is no division of the herds or flocks, no provision is made for the foraging of stock during the dry season, and the animals have to depend entirely on the grazing obtainable. The only care taken is to supply them with water, often very inferior. Dietetics, selection, and other hygienic principles are unknown. The value of the stocks at the present day lie solely in their intrinsic value. It is hoped by a system of gradual education, frequent visits to live stock owners, and giving popular lectures, to eliminate most of the faults perceived.

Grazing and Feeding. The grazing lands are unfenced and are the common property of the peoples irrespective of whether they are the indigenous races or immigrants importing and driving cattle to Ashanti and the Gold Coast Colony. During the rainy season and up to the end of November there is no scarcity of grazing and at this time it is good and abundant. After this time the ground becomes dried, all the grasses become dry and brittle except in pastures in the vicinity of rivers and swamps. The country now begins to be "fired" and gradually becomes a black waste. If the pasture lands were "fired" at what is regarded by Beal as the proper time so as to catch the three or four showers that occur in October and sometimes in November new shoots would grow and this grazing would probably last into the months of December and January, that is, the Harmattan season. After the Harmattan has passed new blades of grass are frequently seen shooting up. On account of this annual "firing" most of the perennial grasses grow deep roots and the annual grasses get destroyed and re-germinated in part from seeds that have been blown about and escape the fire. The natives seem to possess a little knowledge as to the character of the various grasses. The annual firing causes the grasses to be formed almost entirely into ash, containing potash and sodium salts. These serve to invigorate the soil, but potash in excess is deletereous to animal growth. In the low-lying countries there is a deficiency of carbonates and phosphates. The deficiency

in phosphates may account for the small size of the cattle. In the low-lying areas there are no stones whatever, and in the low-lying areas of the north, where the ground is stony, the cattle are larger than those to be found where there are no stones. The difference is not considered to be attributable to the damp atmosphere alone. As one proceeds further north the ground becomes stony with quartzite, granite and laterite outcrops, and still further north it becomes hilly. The action of the rains on these stones washes into the soil carbonates and phosphates of calcium and iron in particular. The cattle of this northern zone are distinctly larger than those of the southern zone, and their size is believed to be due to the greater quantity of carbonates and phosphates in their fodder.

The grasses hitherto identified comprise the following :—*Cenchrus catharticus*, Del. ; *Digitaria horizontalis*, Willd. ; *Eleusine indica*, Gaerth. ; *Eragrostis ciliaris*, Link. (all good fodder) ; *Pennisetum purpurem*, Schum. (the tall elephant grass), indifferent fodder. These were identified by CHIPP (T. F.), late Assistant Conservator of Forests, Gold Coast. The following grasses collected by Beal were identified at Kew :—*Cymbopogon rufus*, *Eragrostis aspera*, *Eragrostis trenule* or *Iryza silvestris*, all found all over the Northern Territories, together with *Arachishypogea*, the wild species and origin of the present-day cultivated ground nut. The seeds of 19 other species were collected and remain to be identified.

Cattle. The breed of cattle in the Territories is the humpless (taurine) type of cattle. A few of the humped (zebu) breed occur, and are usually confined to the divisions bordering on the northern frontier of the Protectorate. Crosses between these two breeds are fairly numerous, especially towards the northern frontier. The origin of the taurine type, which is identical with that found indigenous to Dahomey and French Guinea is a debatable subject. Many writers state that it is of Asiatic origin, having been introduced by the Peuhls in their advance westwards. PÉCAUD, who has made a long study of the cattle in Dahomey, considers that the type is indigenous to Central and West Africa. On the other hand CARDEMOY and WELLAERT disagree for reasons mentioned before. COSSAR EWART has examined the skulls of this breed and believes that it is of Celtic shorthorn origin. Beal agrees that there is a great similiarity between this breed and the British shorthorn when they are both carefully examined in nature, although the West African breed, of course, is degenerate, due to inter-breeding and climatic conditions. There is no record of the early British pioneers having brought out with them any British cattle. Different names are often given to the cattle of different localities in the Territories, thus conveying the impression that there are in existence many different breeds. Beal, however, insists that there is only one breed, and that is the humpless taurine type, and that the Dogomba, Lobi, Dagarti, and other so-called breeds are in reality but one breed slightly distinguishable due to different methods of breeding and climatic conditions. These cattle are small, symmetrical compact animals, very much like a miniature shorthorn. They are slow to mature and reach their full size at the age of 6–8 years. Bulls and bullocks, when allowed to reach their full development, turn out to be very fine animals and for their size would be able to compete against some of the European small fancy breeds, such as the Dexter Kerry cattle. Heifers become sexually mature at from 18 months to 2 years old, bull calves at 15 months. Calves as soon as they can

graze, *i.e.*, when they are about three months old, are muzzled with spikes in certain districts to prevent them from sucking and the mother thus dries off and comes into season again, so as to produce calves yearly. Otherwise calves are not born yearly, and if the cow is left to herself she will give milk from 6 to 9 months. The cow comes into season from 6 to 12 months after calving. A good milking cow gives on an average about 2 pints of milk a day. A table indicating the various body measurements of these animals in the different districts is given. The averages were as follows:—Average age 7 years, length of body to shoulder 46 in., to muzzle 65½ in., girth behind shoulder 54½ in., in front of back 55¾ in., length of fore-arm 11 in., length of thigh 14¾ in., bone below knee 6¾ in., below hock 7 in., head length 16¼ in., breadth 7¼ in., width across loins 13¾ in.

The chief colours of the breed are black, and black and white. Brindles are common and when seen are grey. Red and white and yellow and white also occur. The shape of the horn varies from right-angle projections to those that curve downwards, forwards, and backwards into lyre shape. The feet are usually black, but should white be very predominant the feet are white, or white and black.

The breed is a hardy disease-resisting animal and a very good feeder and forager. The meat, although of good quality and taste, lacks marbling. In the hilly regions and on stony ground it runs into a bigger animal, and in the north along the frontier it is probably mixed with zebu blood but has lost the characters of that breed. The chief faults in connection with the breeding of these cattle are: inter-breeding, commencement of breeding at too early an age, starvation of calves, improper feeding of cow during lactation, no regulation of calving time, abundance of ticks on cows and the infection of cattle while they are young with disease, especially blood diseases. Measures are suggested for remedying these faults.

As a market animal for the butcher the type is small and compact, but fails in not having a larger girth measure in the pubic region as compared with the girth behind the shoulder. It again fails in its hind quarters. The price asked for one of these small cattle is equal to that demanded for a four-year-old humped beast, and in consequence the butchers are not ready to purchase the smaller cattle, unless there is a shortage of humped oxen on the market. The small humpless cattle, however, furnish meat of a better quality. For the purposes of the butcher, however, the larger animal is more greatly in demand. Beal recommends crossing the native animal by using as a sire the humped zebu bull. One hundred of these bulls could be purchased for the sum of £1,000 yearly for five years, branded and issued to the different breeding districts, and changed every two years. Care should be taken to see that these bulls were not diseased. Beal also recommends as an experiment the introduction of say three English bulls of the Hereford breed, not too highly bred or pampered, and 6, 9, and 12 months old respectively. These should be immunised beforehand by the Board of Agriculture against piroplasmosis and anaplasmosis, and two of them should then be exported to Coomassie. If all three survived the effects of the inoculation the 6-months-old bull should be kept back and exported at a later date. The bulls should be used to serve the ten cows and five heifers kept in the Government Herd at Coomassie. These could then be taken up by motor to Tamale and issued to Dagomba breeders to calve down,

the breeders returning to the Government 18-months-old heifers in exchange. With the establishment of a branch of the Veterinary Department at Tamale, and the joining up of Tamale with Coomassie by railway many more bulls could be introduced into the Territory. The experiment with the three bulls would cost the Government about £250, exclusive of motor transport.

Sheep. The sheep of the Territories are small animals which produce hair instead of wool. They were probably introduced by the Peuhls into West Africa. There are two breeds of sheep in Africa which produce hair: one is a fat-tailed sheep descended from the Karakul breed of sheep of Asia, and the other a Moroccan breed of sheep called the Barbarin. The breed found in the Northern Territories is probably descended from the Karakul, but has lost its characteristics through climatic conditions and also by prolonged inter-breeding. The newly-born lamb exhibits the peculiar curl of its hair which is characteristic of the Karakul breed. This curl is soon lost after birth; it is scarcely seen at two weeks, and at a month the hair is entirely straightened out. This is the only breed found in the Territories—a small wire-haired sheep which can be easily picked up and carried. In colour it is pure white, or white and black, or an admixture of white and black. No mixtures of red and white or yellow and white are seen, as occurs in the Fulan or Lagos breed of sheep. The males are furnished with good regular-curved horns, have a crest of hair on their neck, and a long beard of hair running from the jaws to the breast. The ewes sometimes possess a straight stump of horn, have a good and well-shaped udder, and are good mothers. Beal gives measurements of both males and females. Castration is resorted to more often with rams than with bulls, but the faults of breeding are similar to those attached to the cattle breeding. The sheep are readily accepted by butchers in the markets as they have no other supply.

Sheep-breeding is a profitable industry for the Territories to engage upon, as these animals can be bred in every village. Their chief enemies are the hyenas and leopards, which take a considerable toll yearly. The fault of the breed lies in its small size and lack of taste. It thus becomes necessary to introduce foreign blood, as there is no breed available in West Africa for improving the native breed. Two breeds of sheep have done well in Africa, viz., (1) Merino, and (2) the Karakul breeds. The Merino breed is a fairly large sheep which furnishes meat of very good taste and a good fleece of wool. Its fleece would be a drawback in a hot climate, but nevertheless the French Government have done well with this breed in the bend of the Niger north of the Northern Territories. If it is introduced it can only be kept in the open country, and not in the forest country, where the climate is hot and damp. The Karakul sheep is a fair-sized animal with a broad fat rump and tail. It is a haired breed and when the lambs are killed young they furnish a valuable pelt. Both breeds are not pampered sheep, are accustomed to hardships such as scanty fodder and water, and ought to do well in the country.

It is not thought likely that any English breed would be so suitable as they are pampered, and usually live under the best conditions. However, the author suggests that in 1921 a start might be made by introducing two Merino rams and one Dorset ram. These could be used for serving ewes at Coomassie and these ewes could be sent up

to the Dagomba country by motor to lamb, and others brought down for further service and sent back.

Goats. The goat is also an imported animal, probably of Asiatic origin. It is a very small mis-shapen animal, due to many generations of inter-breeding. The general colour is brown. The males are very small for before they have reached their final stage of development they are killed off for food; they possess the usual caprine style of horns. The females are frequently of bad shape but they possess good udders and give plenty of milk to their young; they are not milked by the natives, all the milk furnished being consumed by their young. The breed should receive considerable attention, as it is fast degenerating. The breed recommended for their improvement is the Angora breed of goat. Six males should be introduced in 1921, at a cost of £100.

Horse. Also of recent origin and probably introduced by the Peuhls. This view is supported by the native mythology. From the shape of the head and ears the horse is probably of Arab origin. The colours are chiefly bays, and then come blacks, chestnuts and roans. As a rule they are wanting in bone and good hind quarters. They run up to 14 hands high, but 13.2½ hands is the average size. The larger height is usually seen in imported horses. Very few stallions are castrated, the mares are degenerating and no selection for service by good stallions is practised.

Horses are better cared for than the other domestic stock. They are given an extra diet of ground nut hay, and bean and pea hay during the dry season when grass is scarce. If they are used for riding they are given guinea corn when this is plentiful, or millet. They are housed at night time, but during the day they are hobbled and led out to graze. When grass is scarce they are tied up all day outside the compound or under a tree, and fed on grass cut up as chop. The forelocks, manes, and tails are covered with charms to ward off disease. Measurements are given of stallions in different districts, varying in age from 7–14 years, in height from 13 to 13·3 hands, in bone from 6¾ to 8 in., and in girth from 62½ to 68 in. The horse bred is therefore small in spite of the fact that there is no inter-breeding. This is attributed to two reasons—(1) absence of selection of sire, and (2) deficient dietetics. A mare in season is served by the first horse she comes across, irrespective of its quality. During the gestation period, and after giving birth to the foal, she is not properly fed and the young animal, when it is a year old and upwards to the time that it is broken into the saddle, gets no corn. Both mare and foal have therefore to rely for their nourishment on grazing in a country lacking in calcium carbonate and phosphates.

These faults could be remedied by teaching breeders selection of sires and frequent lectures on dietetics. Afterwards they could be educated on the improvement of the breed. At present horses are not required for draught work in the country as the native relies upon a hoe for tilling and ploughing the soil. If the breed is to be improved so as to render it more suitable for purposes of saddle work only, there ought to be no difficulty in finding suitable English thoroughbred stallions of about 14·1 to 14·3 hands high for this purpose. It would be no use bringing out large stallions to serve these small ponies. However, if they are to be improved for draught purposes one of the small heavy breeds of horses ought to be introduced, and for this purpose the French Percheron is recommended. The author also

strongly advises the introduction of a small plough to replace the primitive hoe, so as to bring about better and more widespread cultivation of the soil, especially so as to obtain legumes for feeding live stock. At present the natives are chiefly concerned with producing just sufficient crop for themselves and their families. The author recommends that the improvement of horse-breeding should be delayed at present until a Branch of the Veterinary Department has been established in the Northern Territories.

Donkey. Also of recent introduction. Donkey-breeding is on the increase. The animal is a fair-sized one as compared with other live stock. It is hardy and a willing worker, light in colour, with the characteristic spinal stripe and frequently with shoulder and leg stripes. Average height 12 to 12·2 hands. The female possesses a good udder, is not milked by the native, and gives a good deal of milk to her young.

Donkeys are housed in the compound at night time. During the day their fore-legs are hobbled and they are led out to graze. The grazing is augmented in the dry season by the addition of ground nut and pea nut hay. They receive very little guinea-corn. No selection of good jacks is made for service, but very little inter-breeding goes on as donkey breeders are continually purchasing new animals or exchanging donkeys for cattle and sheep. Donkeys are used as pack and riding animals.

The future holds forth good prospects for donkeys as pack animals in the transport services of the Territories. On some of the roads 100 lbs. can be easily carried, and a good animal should carry 150 lbs. Their cost and upkeep is very little. The breed requires very little improvement. The only direction in which this is much required is in dietetics during the growing period of the donkey.

Pig. Very few pigs are bred in the Territories. The chief pig-breeding part is in the Kacomba country, Yendi District. The animal is probably descended from the wild wart hog, frequently seen in all the swampy areas. The animals are small and black, the boars are frequently killed off for food before they reach their full development, the females live longer and in consequence appear larger than the boars. The sows farrow easily and have large litters, often 11 or 12 in the litter.

The pigs are housed in a small house outside the compound. The principal food is found by scavenging around and about the villages, and in foraging and rooting in the farms. The Kacomba people take special care of their pig, as they consider it a tasty article of diet; they are watered and fed on cassava when the country has dried up and roots are scarce.

Pig breeding ought to be encouraged among the pagan peoples. The chief obstacle is the scavenging and rooting methods of the pigs on the farms. It is useless to confine them in styes, as they do not do well in confinement. They require a run of the grazing areas, so that they can root and find their food. Breeding should be encouraged so as to augment the available source of food material for the native, and thus relieve the already great demand made on cattle, sheep and goats. In large villages pigs would probably be a nuisance, but in the smaller ones they could be made the basis of a profitable industry.

In the Gold Coast Colony, along the coast line and behind the lagoons, countless number of pigs are bred and require improving. In Ashanti

where the pig industry is gradually being exterminated at the whim of the white man, it requires encouraging and improving.

The introduction of English boars and sows for the improvement of the indigenous pig should be kept back until the personnel and functions of the Veterinary Department are increased. It is useless to introduce pigs and hand them over to the native to bring about improvement of the breed.

Poultry.—(1) Fowls. The native fowl kept by every household is a small hardy bird of almost every colour, with game features predominant. Fowls of this sort are kept and reared by the natives for their own use and for the market. They can readily be improved and respond well to the introduction of European blood. The best cross is with game and Orpington birds.

Ducks. Do well and thrive in districts where bred. No improvement required.

Turkeys. Where these birds are kept and bred they do well, but few are bred in the Northern Territories. The industry requires developing in order to ensure the future food supply of Ashanti. It is recommended that 100 turkeys should be purchased in the Addah and Quittah Districts, and sold to the natives in the Northern Territories to commence breeding operations.

Pigeons. Wherever there is a Mahommedan settlement these are bred. No improvement required.

Guinea Fowls. These are bred by every household. Immense numbers are bred by the Kanjargas and Fra Fras, as their women are not allowed to eat the ordinary fowl.

Ostrich. Not bred in the country. Those seen are imported from Upper Senegal and Niger, and are kept to supply the itinerant trade in ostrich feathers. When meat is scarce they are frequently killed for food and eaten by the people.

Guinea-pig. In certain large towns where there is a Mahommedan settlement this animal is bred for food.

Increase and decrease of live stock. Dealing with the yearly losses among stock, the author makes these out to be at present very serious, and the losses amount to at least 35 per cent., made up as follows :— Diseases 22 per cent., sales 5 per cent., transfer out of Northern Territories 2 per cent., killed to satisfy the native customs 3 per cent., wild animal attacks 2 per cent. (probably much higher for poultry), and presents 1 per cent.

It is suggested that these losses can be prevented (1) by placing their control entirely in the hands of a Veterinary Department with a sufficient staff to cope with animal diseases ; (2) the sale of bulls and bullocks should not be hindered, but they should not be sold under a certain age—two years old—before they have completed their growth. Barren cows and old cows that have gone barren should be sold only under permission of a competent authority. Sales of heifers and cows for the butcher should be prohibited. A high export duty should be placed on the transfer and bartering of cows out of the Territories ; (3) a regulation should be framed prohibiting the slaughter of females, whether of cattle, sheep or goats ; (4) a freer issue of shot-guns and more powder should be allowed to enable people to keep down wild animals. The natural enemies of poultry—kites, hawks and eagles take a heavy toll—about 30 per cent. of the chicks. Nothing can be done to eliminate their attacks. But when

the country is opened up wire netting ought to be obtainable so that the chicks could be placed in runs.

The author next discusses the conditions as they affect animal-breeding in each of the districts named above, and deals in particular with the diseases encountered.

Entomological Situation and its Relation to the Live Stock Industry. A number of observations on this question were made during tours of inspection.

The tsetse fly question in its relation to live stock breeding appears to be somewhat complicated. SIMPSON (J.) has already studied the factors influencing the distribution and prevalence of this fly in the Territories (see this *Bulletin* 1918, Vol. 6, p. 78).

This observer maintained that if the country were thoroughly searched tsetse could be found everywhere and that so-called fly belts did not exist in reality; in other words, if the country were thoroughly searched the fly would be found linking up these belts. He further asserted that certain precautions taken in the Territories with regard to excluding horses from them only led to a false sense of security. Beal, on the contrary, does not adhere to this view, and claims that there are "pockets" in the Territories free from tsetse running from 1 sq. mile to 10 sq. miles in extent. On certain days it is admitted that tsetse scatter for their food and may be found in an area where they were never seen before and which is totally unsuited for them; their natural instinct, however, is to remain close to their birth place, and the areas free from fly are indicated on a map. The chief species found were the following:—

Glossina morsitans, fairly common, an inland fly not seen in pure savannah districts but seen in the so-called savannah forest districts, especially in close and muggy places (*e.g.*, Makongo, Yamalaga, Daboya, Zantana).

G. tachinoides, very common, confined to the river system. During the rains they may be found alongside rivers with grass banks, but they are chiefly confined to river banks covered with shrubs and small scrub (*e.g.*, Rivers Sissili and Kulpawn).

G. palpalis, fairly rare, chiefly found on river banks covered with a dense undergrowth and overgrowth [*e.g.*, Rivers Volta (White and Black)].

Among the indigenous live stock outbreaks of trypanosomiasis with resulting heavy mortality do not occur. Such outbreaks have occurred among horses, but these have usually been imported animals. The live stock in the fly areas do not appear to suffer any appreciable harm by living there; although these animals are small they are as a rule plump. It would therefore appear that the native live stock has acquired a high degree of resistance to the prevailing strains of trypanosome. Among the native breeders the fly is not blamed for the production of any disease.

Stomoxys. The common stable fly is met with wherever there is live stock. The species most commonly found is *S. calcitrans*, which is confined to the villages and, as a rule, does not follow live stock out to grass. The author in 1912 in investigating an outbreak of trypanosomiasis among horses at Accra attributed the spread of the disease to Stomoxys and Lyperosia flies found in the district. Given a reservoir of infection Stomoxys appears to be capable of maintaining an enzootic centre in an area. These flies also act as carriers of two

worms—*Habronema microstoma* and *H. macrostoma*—found in the stomach of the horse and donkey.

Hippoboscidae. The common species found is *Hippobosca maculata*, or cattle fly, a yellowish red fly, with a very hard skin, and exceedingly difficult to kill. Capable of transmitting trypanosomiasis mechanically, like Stomoxys.

Tabanidae. Known as the swamp or mango fly. Many species are found and cause annoyance to cattle, which fear attack from this fly very much. Also incriminated with maintaining an enzootic centre of trypanosomiasis by mechanical transmission.

Molluscs, Gasteropods (snails and slugs). Worm parasites which require to pass certain stages of their life history in snails, such as, for example, the common liver fluke of cattle, sheep, and goats, are found. The horse fluke, *Gastrodiscus aegyptiacus*, is also mentioned.

Ticks. The only method at present adopted for ridding the country of ticks is to burn the pastures at a certain time of the year, but this process is unsatisfactory. The ticks are subject to attacks of natural enemies, such as the white cow bird or tick bird and the domestic fowl. The native cattle owners have always been accustomed to seeing ticks on their stock and do not attach much importance to them. They seem to be quite unaware of the continual drain of blood from the system (estimated at up to 500 lbs. of blood in the course of a year). Ticks cause marked stunting of growth which renders the animal unfit for the butcher two years longer than it would have otherwise been. The decrease in the milk yield of milch cows due to these parasites may amount to over 40 per cent. Tick bites also cause marked depreciation in the value of the hide. The ticks found in the Territories have also been studied by SIMPSON (*loc. cit.*). They are the following :—

Amblyomma splendidum, fairly rare, found on cattle; as far as is known it does not transmit disease.

A. variegatum, common, found on cattle and sheep to which, however, it does not appear to transmit any specific disease.

Boophilus australis, common, found on cattle, transmits redwater.

B. decoloratus, very common, found on cattle, sheep and goats, conveys redwater and also, it is said, spirochaetosis in cattle.

Haemaphysalis aciculifer (not encountered by Beal).

H. leachi, found on carnivora, especially the dog, rarely on cattle, sheep, goats and horses. Transmits canine piroplasmosis.

Hyalomma aegypticum, common, found on all domesticated animals, transmits bovine redwater.

Rhipicephalus sanguineus, common, found on dogs, sheep and goats, transmits canine piroplasmosis.

R. simus, common, found on cattle, transmits East Coast Fever.

The more important Epizootic Diseases of Live Stock. These include anthrax, contagious bovine pleuro-pneumonia, contagious foot rot, epizootic lymphangitis, filariasis, fowl cholera, piroplasmosis, rinderpest, haemorrhagic septicaemia, and trypanosomiasis.

Anthrax.—This disease prevails especially during the dry season, when the swamps have dried up and the underlying ground becomes available for grazing. It is particularly when the grasses are eaten right down close to the ground that the animals become attacked. It seems that hundreds of cattle, sheep and goats become yearly affected with this disease and recover, and it is probable that some are infected

many times during their life. Three forms of the disease are described, viz. : (1) the epileptic form, in which the animal may succumb at any time from within 6 to 24 hours after first showing symptoms ; (2) an internal form, in which after showing symptoms of fever and colic the animal may pass blood-tinged faeces on the second and third day and sometimes streaks of blood from the nostrils ; these animals are usually destroyed ; (3) a local form in which the lesions are confined to the skin or to the throat, swellings being formed which are frequently attributed to snake-bite. Death when it does occur takes place on the third or fourth day. In addition, many animals contract a mild form of the disease and show no outward appearance of being affected.

Sporadic cases are frequently noted all over the Protectorate and the mortality rate is estimated at 4 per cent. per annum for cattle and probably higher for sheep and goats. The disease is fairly rare among horses and donkeys as their feeding is better looked after.

Contagious bovine pleuro-pneumonia.—The zebu breed of cattle is stated to be most susceptible, on account of the large circulatory and lymphatic system in these animals. The breed of cattle found in the country is not so susceptible. The cattle that are noticed to become affected are the more docile ones, which tend to remain in close proximity to the infected animals. In the Northern Territories the disease is spread and kept alive on account of the fact that all grazing rights and water are common property and cattle are transferred as marriage settlements. A clean herd may travel for water or grazing from 2 to 10 miles and is then brought home and perhaps next sent in another direction for pasture or water. In this way the disease may be carried considerable distances. An active unrestricted commerce in cattle is also a prolific means of spread. During the years 1912–1914, when the disease broke out in the Territories, the Government was duly warned to take action to control the importation and movement of cattle through the country, but no action was taken, with the result that the disease is now enzootic and takes a yearly toll of about 13 per cent. of cattle.

In order to ascertain the presence of the disease in a suspected herd the best method is to visit the kraal early in the morning before the animals are disturbed and listen for animals that cough. After making the animals travel a little distance (about 400 yards) others can again be picked out. These animals should be segregated.

Contagious foot rot.—Cattle, sheep, and goats are frequently affected with this disease during the rainy season, when the cattle compounds may become so sodden that the animals stand up to their knees and hocks in mud. The affected feet emit a foetid odour and a black stinking discharge can be squeezed out of the heels and soles. The condition is probably due to the necrosis bacillus. Usually two or three animals in a herd or flock are affected with this condition.

Epizootic lymphangitis.—This disease is known to the natives as "yaws." It is not very common, but many cases can be seen among horses on making careful investigation. It is said to be spread by the agency of flies, heel ropes, and saddlery equipment. The natives do not consider the condition contagious and hence the affected animals are not segregated. In the treatment of the disease they use charcoal, black antimony and copper sulphate. As a rule, these cases recover after a long period of treatment.

Filariasis.—Live stock are said to suffer from a filarial infection, transmitted by some species of Culex. The mature worm is frequently found in the peritoneal cavity of the horse, ox, sheep and goat. The embryos are often seen in blood smears taken from cattle and horses. The extent of the damage done to cattle by the infestation was not ascertained, but in horses it appears to be the cause of an intermittent fever associated with other symptoms. [For observations on this condition in the adjoining French territories see this *Bulletin*, 1920, Vol. 8, No 2, p. 126.]

Fowl cholera.—This appears to be a serious disease of poultry, characterised by symptoms of profuse diarrhoea and dejection with death in from 1 to 3 days.

Piroplasmosis.—The most frequently found piroplasms of cattle in the Northern Territories are *Piroplasma bigeminum*, *Theileria mutans*, and a third piroplasm which is occasionally met with and was described by the author in his Annual Report for 1911. The last-mentioned parasite has also been recognised by MACFIE (J.), who identified it provisionally as a species belonging to the genus *Achromaticus*. These parasites set up merely benign affections, inasmuch as all calves become infected shortly after birth.

T. parva, the cause of East Coast fever of cattle, has not, according to the author, been discovered in the country in spite of frequent search. A tick which is capable of producing its spread, viz., *Rhipicephalus simus*, exists and would represent a serious factor if the disease should ever be introduced. There is, in fact, communication between the country and Central and East Africa, via the Lake Chad district, and therefore West Africa lies open to its introduction at any time.

The horse is also said to be subject to infection with *Nuttallia equi*, which produces a dangerous anaemia frequently terminating in death. Up to the present time piroplasmosis has not been detected in sheep.

Rinderpest.—An epizootic of this disease affected the country in the year 1916, and raged up to the early part of 1918, causing a mortality of 50 per cent. of the cattle. It is said to have been introduced to West Africa from Central Africa via Lake Chad and the French territories by means of cattle caravans. The disease is not enzootic in the country and the conditions are said to be such that it is not likely to become enzootic, on account of the fact that the country is nearly all savannah country exposed to direct heat and sunlight, and the temperature is too high for the maintenance of the virus for a long time outside the body (solar max. 145° F., shade max. 95°, shade min. 59°, with a range of 35°). It was noticed that calves born of cows that had passed through an attack of the disease during their last months of gestation were usually immune.

Haemorrhagic septicaemia.—This disease, caused by organisms of the fowl cholera group, affects cattle, sheep and goats. In cattle it is fairly rare, and so far has only been met with in Coomassie; three forms were recognised, viz., a pulmonary form, an intestinal form, and a local form. It is difficult to distinguish these diseases from anthrax except by means of the microscope. Death occurs in from 12 hours to 4 days.

In the sheep and goat the disease is fairly common. The pulmonary and intestinal forms are most frequently met with and usually occur simultaneously in an affected animal.

Trypanosomiasis.—Three species, or rather types, of trypanosomes are known to occur in the Northern Territories, viz., *T. brucei* (*pecaudi*), *vivax* (*cazalboui*), and *congolense*. The disease is transmitted by the bites of the tsetse fly, and other biting flies are capable of maintaining a local focus of the infection by mechanically transmitting the infection.

The symptoms caused by all three species are very nearly the same in horses, but infection caused by *T. vivax*, however, is not so severe as that caused by *T. brucei*. Most of the recoveries that do take place occur after *T. vivax* infection. Symptoms are first noticed in the horses in from 17 to 45 days after infection, when the animal suddenly develops a number of urticarial swellings each about the size of a shilling and called plaques. These swellings disappear in about three or four days, when the animal becomes affected with a puffy swelling in the fetlock region. The scrotum and submaxillary glands then become enlarged and swollen. There is lachrymation from both eyes and the conjunctival mucous membrane becomes yellowish and covered with a number of petechiae. A swelling develops under the abdomen and runs forward or backwards, the muscles of the loins and quarters appear to have become wasted and shrunk. These symptoms develop during the first month and during this time the temperature is very irregular, on some days 105° and on others 103°.

During the second month wasting of the muscles and weakness of the hind quarters are particularly marked, the horse sways on moving, drags its hind legs, and does not flex its joints. The appetite diminishes, the joints become enlarged, the scrotum and sheath are markedly swollen and the temperature varies from 102° to 103°.

During the third month emaciation in particular is very marked and all the other symptoms are more pronounced, the horse becomes very weak, and affected with paraphimosis, the mucous membranes are blanched and the anus relaxed. Finally, the horse lies down exhausted and dies in two or three days.

Atoxyl is considered to be undoubtedly the best drug to use for treatment, combined with good nursing and feeding, in cases that are not too far advanced.

In cattle *T. vivax* does not appear to cause much harm and no symptoms were observed. *T. brucei* is said to cause a sudden emaciation, which becomes chronic and lasts for a year, after which the cattle gain some degree of tolerance towards the infection and commence to put on flesh again. In imported horned cattle that have to travel long distances by road emaciation and weakness of the hind quarters are noticed and on account of the hardships these animals have to endure they usually fall exhausted at the end of the journey and die within two days. *T. congolense* was first discovered by the author in the country in 1912 and hitherto has only been found naturally in horses, in which all the chief symptoms of trypanosomiasis were seen. It is said to be not so virulent as *T. brucei*, but more virulent than *T. vivax*. By experimental inoculation it was very fatal to the sheep, goat and dog.

Cattle Trade.—This trade appears to be small and many more cattle could be exported if the herds were increased. It is estimated roughly that the trade in indigenous cattle for the year 1919 could be represented at 2,000 head.

Position of the Meat Supply. At the present day this supply comes from the French Territories. Early in 1914 the French authorities

opened two large abattoirs with refrigerators at Lydianne and Bamako for the exportation of chilled beef to France from the Port of Dakar. Lydianne dealt with about 300 carcases a day during the war. In 1915–1917 rinderpest ravaged their herds and killed off from 40 to 70 per cent. of the cattle and the export of cattle from French West Africa was prohibited in order to conserve the supply of meat. However, the Ordinance was subsequently modified so that certain spheres of the French country were allotted for the supply of the British Colonies of Nigeria and Gold Coast. These spheres are indicated in a map which accompanies the Report. In the event of further developments taking place in the chilled meat exporting industry of the French territories the meat supply of the Northern Territories may, however, at some future date become seriously endangered, for the country itself is not in a position as yet to supply the 40,000 head of cattle required yearly for the butcher. Even at the present time the trade from the French territories is gradually decreasing.

Cattle Routes.—The present method of importation of cattle (from the French territories to the Gold Coast) through the Territories is undesirable, for the country is open and unfenced and the breeding districts lie at the mercy of the cattle trader, who may introduce and disseminate disease with his animals. Prior to importation, therefore, the cattle ought to be submitted for examination, or else certain routes ought to be laid down along which the cattle droves are compelled to pass to the markets, under pain of heavy penalties if they are found off the routes. The principal ports of entry are at Bawku and Paga. Water and grazing would have to be provided along these routes. A series of routes are suggested and traced out.

Estimated Live Stock Census and Valuation in the Northern Territories and Yendi District. Cattle 68,500 head, valued at £548,000 (40,967 head of these cattle were inspected and valued at £327,736). The average price of cattle was taken at £8.

Sheep and goats, 150,000 head, valued at £75,000 (50,931 head were checked and valued at £25,466). Sheep and goats were valued each at 10s.

Horses, 1,097, valued at £10,970.

Donkeys, 2,003, valued at £10,015. The horse was valued at £10 and the donkey at £5.

Pigs, 321, valued at £963. The pig was valued at £3.

The total estimated value of live stock, therefore, amounts to £646,985, and somewhat over half of these animals were inspected. The estimated expenditure of the Veterinary Department for the year 1920 was £3,799. It is therefore computed that the Government spend 1¼d. in the £1 to safeguard the industry, a sum which is not regarded as very generous.

Beal makes a number of important recommendations with regard to the re-organisation of the Veterinary Department, and the division of the Department into three sections, viz., a veterinary section, live stock section, and legislation section.

NYASALAND PROTECTORATE. **Veterinary Report for the Year ending 31st March, 1920.** [GRIFFITHS (J. A.), Chief Veterinary Officer]. Annual Report of the Department of Agriculture, Nyasaland. pp. 8–10, f'cap. Zomba: Govt. Ptr.

Rinderpest. The Rinderpest Commission which carried out the operations for the formation of the "Immune Belt" in Tanganyika

Territory, Lakes Nyasa and Tanganyika, terminated their work in April, 1919.

At present the situation with regard to this disease is quite satisfactory for there exists a belt of country in which all the cattle were immunised during 1917 and 1918, and to the south of this there is a belt between the lakes which is cleared of cattle. In Nyasaland, to the south of the cattle-free belt, there is a control area in which the cattle are registered, births and deaths recorded, and movements of cattle only allowed under permit. There does not appear to be any rinderpest in the districts immediately to the north of the immune belt.

No outbreak of East Coast fever has occurred outside the areas in which this disease is enzootic.

In areas settled by Europeans there has been very little trouble from tick-borne diseases, except when dipping has been neglected. More dipping tanks are being built every year so that it will soon be possible for most cattle owners to have a dipping tank available within easy distance.

There have been a few cases of demodectic mange in cattle in the Blantyre district and all these cattle were slaughtered.

Outbreaks of trypanosomiasis have occurred in cattle in various parts of the Shire Highlands, especially on the Namiwawa stream, south of Zomba. In two outbreaks there was a history that the animals had previously been brought through tsetse belts, but in the other outbreaks the sick animals did not appear to have been near the belts. On the Government Farm at Namiwawa the disease has occurred sporadically among the working oxen for several seasons, in spite of the elimination by slaughter of animals found by microscopic examination of the blood to be infected. No tsetse fly occur on or near the farm. Thus the disease must have been transmitted by flies other than tsetse. Drug treatment seems to be of value in all cases where the disease is not far advanced. As the result of treatment the animal's life is prolonged and its condition improved to such an extent that it can be fattened for slaughter, while in about 60 per cent. of the favourable cases the animals are able to resume work.

A fairly large number of cattle succumb with gastro-enteritis as a prominent symptom. The chief causes are : (1) arsenical poisoning ; (2) coccidiosis ; (3) poisonous plants ; and (4) parasites. Intestinal round worms in calves are the cause of heavy losses among young stock throughout the Shire Highlands. The liver fluke also accounts for losses among cattle when the animals have had to undergo a long journey or have had their vitality reduced by some other cause.

In sheep the chief diseases are : (1) Distomiasis, due to *Fasciola gigantica*, the cause of losses among European-owned sheep in the Zomba district ; (2) tape worms, said to infect the bile ducts as well as the intestines and said to be the cause of poverty in condition throughout the Highlands ; (3) contagious pneumonia—one outbreak in which there was a high mortality is reported ; and (4) grass poisoning, which caused heavy losses in a certain marshy district owing to the animals feeding on fermenting vegetation after the floods had subsided.

Pseudo-rabies. This disease, which affects dogs and cats in Nyasaland, clinically closely resembles true rabies. It is apparently transmitted by the bite of an infected dog. In six cases observed there was a history that the animals had been bitten by an apparently

rabid stray dog about a fortnight before symptoms were seen. The symptoms are first uneasiness, difficulty in swallowing, dribbling of saliva, followed by a general hyperaesthetic condition with twitching of the muscles and loss of co-ordination of the limbs. As the condition progresses the animal emits at intervals a peculiar wailing cry and just before death snaps at imaginary objects. On post-mortem the stomach is found to contain various foreign bodies, as in true rabies. Human beings have not been reported to have contracted the disease. In only one case has a positive reaction been obtained by the biological test for rabies with material from an apparently rabid dog (GARDEN, 1916).

Importations. During the year 18 bulls and 164 cows were imported for breeding purposes and 252 head of slaughter stock and trek oxen, together with 23 pigs, 10 dogs, and 1 donkey. Cattle of the Aberdeen-Angus, Sussex, and Ayrshire breeds have been imported and distributed in various parts of the southern districts for stud purposes. Pigs of the Berkshire breed were imported for breeding purposes.

The Veterinary Staff appears to be inadequate for the work demanded of it and there is urgent need for a research laboratory. Stock of all kinds have increased from 100 to 200 per cent. in market value. A number of diseases require special research.

BRITISH GUIANA. **Report on Recent and Present Veterinary Problems in British Guiana.** [HARRISON (J. B.), Director, Dept. of Science and Agriculture.]. MS. Report received by Colonial Office, 15th July 1920. 14 pp. f'cap.

Harrison, who holds the post of Director of Science and Agriculture in British Guiana, states that the country at the present time is singularly free from infectious and other diseases of live stock other than Texas fever. This disease is enzootic among cattle in the coastlands and consequently the cattle in the coastlands are of a relatively small, stunted type, as compared with the larger, more healthy-looking cattle found inland. All cattle imported into the coastland counties from Great Britain, Canada or the northern parts of the United States of America are attacked with this disease within 2 to 5 months of their arrival, and, as a rule, they quickly succumb. If they do recover they are generally useless for breeding purposes. This difficulty has been got over by importing high grade bulls and cows for the improvement of the local strains from the southern parts of the United States, where Texas fever is enzootic, and these animals are therefore almost immune towards infection with the local type of the disease.

In the '80's and '90's the coastlands cattle were often affected with severe outbreaks of anthrax. This disease was, however, brought under control by isolation of affected areas, together with compulsory inoculation with anthrax vaccine. Stringent steps are now taken by the Department of Agriculture whenever a sporadic case of the disease occurs. Nevertheless, recurrent cases continue to occur on two plantations and it was noted that the disease appeared on one pasture only of each estate. These pastures were specially treated; all animals on the estate were inoculated with vaccine and removed to and isolated on non-infected pastures. The cattle pens and byres were destroyed and the pastures all closed to cattle and completely flooded with water. The closure and flooding were continued for nearly two years, and these two estates have now been

free from anthrax for over four years. The coastland districts have now been freed almost completely of anthrax by systematic and compulsory inoculation of all susceptible animals found within large areas around each outbreak.

Tuberculosis does not appear to be common among cattle, although information upon this point is not satisfactory.

Glanders is of rare occurrence in the coastlands and only 17 cases have been reported during the last eight years.

Cattle are stated to be subject to very acute attacks of trypanosomiasis, which invariably proves fatal in from 26 to 48 hours. Treatment of this disease was attempted by using a preparation called sodium protosanate, with good results.

Mal de caderas was first detected on a sugar plantation in Berbice in November, 1912. Horses were first attacked, in many cases with rapidly fatal results, and then the disease spread from the horses to the mules. Owing to a faulty diagnosis the disease was allowed to spread through the estates and every animal attacked died. As a few of the affected mules showed signs of recovery some owners were unwilling to protect their other animals by destroying at once those showing well-marked symptoms. In 1914 the Department of Agriculture adopted stringent precautions to prevent its further spread, by strictly isolating every affected plantation until the owners assented to the destruction of all diseased animals. In this way the disease was stamped out.

A few outbreaks of cerebro-spinal meningitis (in horses) were reported prior to 1913, but no cases have been identified since that year.

Occasional cases of contagious pleuro-pneumonia (in bovines) have been seen, but the spread of this disease has been readily prevented by adopting certain precautions. The mortality in the outbreaks varied from 14 to 25 per cent. of the animals attacked.

Only one case of dourine has been reported during the last 16 years.

Until April 1914 pigs were very free from disease. An outbreak of swine fever occurred on that date and lasted up to October of that year. Several thousands of pigs succumbed to it, but its spread throughout the colony was stopped by very severe isolation of the farms and districts where it occurred. No outbreak was reported during 1915, but in 1916 the disease again appeared in isolated areas in a certain district. Its further spread, however, was stopped by destruction of all infected animals and all pig pens and isolation of the farms on which it had occurred.

As far as can be ascertained the cattle in the pastoral districts of the hinterland are quite free from disease.

Dogs and cats are very subject to intestinal parasites.

The various laws dealing with infectious diseases of animals have recently been consolidated into one Ordinance (No. 5 of 1920). Likewise unnecessary cruelty to animals during surgical operations has been guarded against in a recently enacted law.

According to the census returns for the years 1915–1919 the average number of animals in the coastlands was :—horses 1,000, donkeys 6,400, mules 2,300, cattle 84,000, buffaloes 180, goats 13,200, sheep 21,600, pigs 13,200. In the inland savannah districts the estimated numbers were :—horses 600, cattle 30,000. The live stock on the coastlands are spread at intervals over an area having a frontage to the sea of 180 miles, with an average depth of about 7 miles. The

Government Veterinary Staff is at present sufficient to supply the needs of one county only. Up to 8 years ago there were at least six qualified veterinary surgeons besides the Government Veterinary Surgeon in the Colony, but now there is only one.

The defects in the qualifications of many locally registered veterinary surgeons are due to an Ordinance passed in 1909, which entitled any person who was engaged in practice to be registered as a veterinary surgeon. This Ordinance has now been repealed. There appears to be a notable deficiency in the number of trained veterinary surgeons in the Colony.

In coping with infectious diseases it is also a great disadvantage that the one veterinary surgeon remaining in the Colony is allowed to indulge in private practice. Funds do not appear to be adequate to engage the services of a whole-time veterinary surgeon.

The Sugar Planters' Experiment Station Committee have recently investigated this matter, and reported on the necessity of having a staff specially skilled in tropical diseases of live stock.